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BY THOMAS SMITH,
Author of the Sacred Mirror, Universal Atlas, &c.

REVISED AND IMPROVED.

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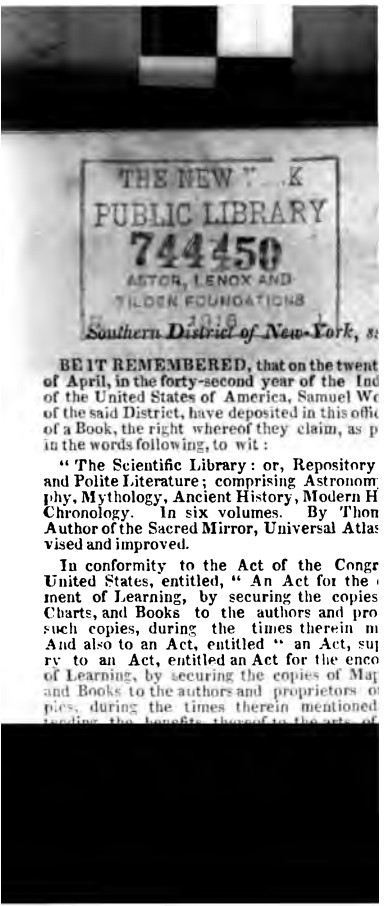
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A

COMPENDIOUS SYSTEM

OF

ASTRONOMY.

———————————you cannot go
Where UNIVERSAL LOVE not smiles around,
Sustaining all yon orbs, and all their sons.

THOMSON.

BY THOMAS SMITH.

Author of the Sacred Mirror, Universal Atlas, &c.

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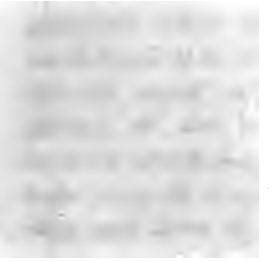
EXPLANATION

OF THE

FRONTISPIECE.

ASTRONOMY.

IN affectionate mother instructing young daughter in the use of the telpe, by which we become more intiely acquainted with the heavenly ies. She has just directed her to obe the mountains in the moon, which supposed to be about three miles h.



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A Vocabulary of Astronomical Ter

A

COMPENDIOUS SYSTEM

OF

ASTRONOMY.

CHAPTER I.

Origin of Astronomy.....Improvements in that fascinating science.... And peculiar advantages resulting from the study of it.

IN the early ages of the world, when the attention of mankind was principally devoted to pastoral or agricultural concerns, the return of particular seasons was an object which they naturally wished to ascertain; and though their first observations were few, and extremely limited, their importance was sufficiently obvious to stimulate to new and deeper researches.

The Chaldean husbandman perceived that the cheering influences of the sun were more

interesting knowledge, from va
regular changes of the moon, and
ent situations in which she rose and
horizon.

Equally incited by necessity a
tates of curiosity, the ancient a
next turned their attention to the
vens; and began to group the s
into constellations, under such nam
ed best adapted to the respective se
the sun was in those signs; thus en
to ascertain the time of the sun's a
volution.

The zodiac, or circle of animal
ded into twelve parts, whose nam
racters were as follows:

♈ Aries, the ram; ♉ Taurus
♊ Gemini, the twins; ♋ Cance

ded to denote the retrograde motion
sun, after his arrival at a certain height
the horizon; the figure of Leo, or the
ste introduced as emblematic of the ex-
heat and raging sensations experienced
the sun was passing under the next con-
tion Virgo, or the virgin, evidently al-
ts the period when the maiden gleaners
busied in gathering the refuse of the
st; Libra, or the balance, afforded a
ng hieroglyphic of the equal division
day and night; the venomous qualities of
corpion alluded to the diseases which
y insue on the fall of the leaf; Sagitta-
or the archer, was an apt symbol of the
ing season; Capricorn, or the goat,
delights in climbing rocks, &c. served
press the circumstance of the sun ascend-
gain to its highest situation: and Aqua-
nd Pisces were symbolical of the rainy
n.

e observation of the polar star enabled
Phœnicians to extend that commerce,
tendered them such an opulent and
stable nation: and Thales the Milesian,
g become acquainted with the important
, communicated it to the Ionians, by
the knowledge of astronomy was grad-
diffused over all parts of Greece. The
celebrated character discovered the sols-
and equinoxes; divided the globe into
nes; and also divided the year into three
nd and sixty-five days.

After the death of Thales, Pythagor started the idea, that the diurnal motion of t sun and stars was not real, but occasioned the motion of the earth on its axis; and th all the planets turned round the great lumin ry, which, in respect to them, was at rest the centre of the system.

After this time the study of astronomy w neglected for nearly two hundred years; a even when revived by the Ptolemys of Egy their ideas on the subject were by no mea consonant with those of Pythagoras: the system however, though erroneous, served give the observers of that age, a tolerable id of the apparent course of the heavenly bodie and enabled them to reduce the science geography to some certain rules.

In the fifteenth century, Copernicus revi ed the ancient Pythagorean system; and the year 1610, Gallileo, a native of Italy, i troduced telescopes into the service of astro omy, by which means he discovered the spo in the Sun, and its revolution on its axis; t mountains on the Moon, the phases of Satu

r of comets, together with astronomical
)les and a catalogue of the stars: and the
idies of Mr. Flamstead and Dr. Herschel
ve afforded much new and curious informa-
n on this truly fascinating subject.
The advantages resulting from the study of
ronomy are equally numerous and impor-
it—calculated to expand and dignify the
nd, to correct and improve our ideas, and
raise our contemplations from earth to hea-
n, and from the creatures to the infinitely
se and adorable Creator. By means of this
valuable science, we discover the source of
the celestial motions, follow the immense
rks of the Deity through the wide regions
the firmament; trace the various causes
ich regulate the vast machine of the uni-
se, and exclaim with the royal Psalmist,
The heavens declare the glory of God!"
tronomy, also, is calculated to obliterate
m the mind the effects of timidity, and su-
stition, exposing in its true colours the ridi-
ous system of astrology, and teaching
nkind to look with tranquillity and compo-
e on those phenomena which were once
sidered portentous of the death of potenta-
es, the destruction of empires, or the anni-
ation of the universe.—From the heavens
have obtained all our knowledge of the
sons, and the art of reckoning by certain
iods of time, than which nothing is more
essary in the common affairs of life; and
intimately connected are the studies of the

that it is the acknowledged [illegible]
religion.

CHAPTER II.

Of the Solar System.....Fixed St
Ecliptic, &c.

THE solar system derives its n
Sol, the Sun, because the Sun is su
be at rest in the centre, while all th
with their moons and satellites rev
it at various distances. By certai
its disk, however, the great luminar
found to turn round on its axis in

appearances and effects, it seems most
to conclude, that it is no other than
ntary fire; or, perhaps, that it is the
ntre of attraction to all the elemen-
in the planetary system, and that
by one law of nature, a constant
on of fire from the planets to the sun,
equivalent to that which is, by ano-
, incessantly effused from the sun upon
ets.

odies which move round the sun as
ntre of motion are called planets; and
seven of them have been distinguish-
ronomers with the following charac-
appellations:

rcury; ♀ Venus; ⊕ the Earth;
s; ♃ Jupiter: ♄ Saturn; ♅ the
n Sidus, or Herschel.

URY, the nearest planet to the sun,
his revolution in about 87 days, 23
hich is the length of his year. His
from the centre of the system is about
00 of miles; his diameter is computed
thousand two hundred; and in his
on round the sun he moves at the rate
ndred and five thousand miles an

planet exhibits phases like the moon,
monstrates that, notwithstanding his
ble brilliancy, he shines only by bor-
ght. The times of his appearance are
efore sun-rise and a little after sun-

to the west of the sun she is called t
ing star, and when she appears to th
the sun, she is denominated an even
occupying each situation alternately
290 days. If viewed through a teles
seems to have all the phases and app
of the moon, and at her brightest t
exhibits a more beautiful appearance
other of the heavenly bodies.

The EARTH, which we inhabit, is
planet above Venus, situated at the
of 95,000,000 of miles from the sun
ameter is 7,900 miles, the circumf
its orbit 598,000,000 and its mea
motion, 58,060 miles an hour, by
performs its revolution in 365 days,
and 49 minutes. It likewise turns
axis every twenty-four hours, from

...ap, whose distance from the sun is com-
...ut a hundred and forty-four millions of
..., is near four thousand two hundred
...in diameter; and the circumference of
...rbit is nine hundred and twelve millions
...iles, through which he revolves in rather
...than two of our years. His mean motion
...his orbit is about fifty-five thousand miles
...hour; and his diurnal rotation is perform-
...in twenty-four hours and thirty-nine
...inutes. This planet is of a fiery red colour,
...ppearing sometimes near the sun, and at
...four times more distant, rising when that lu-
...minary sets, and setting when it rises. He
...sometimes exhibits a gibbous appearance, but
...never horned like the moon; which plainly
...demonstrates, that his orbit includes that of
...our earth, and that he shines only by reflected
...light. Two white circles have been discover-
...ed round the poles of this planet, which are
...supposed, by Dr Herschel, to originate from
...the snow lying about those parts.

JUPITER, one of the largest of the planets,
...is about four hundred and ninety millions of
...miles distant from the sun, and by moving at
...the rate of twenty-nine thousand miles an
...hour, he completes his annual revolution in
...four thousand three hundred and thirty-two
...days nine hours. His diameter is eighty-
...nine thousand miles, which is eleven times
...as much as that of the earth; yet such is the
...astonishing rapidity of his motion on his axis,
...that he performs his diurnal rotation in the

variety of ... face; and the satellites, which afford light to this planet during the absen sun, as our moon affords us.

SATURN, the next planet in the s yond Jupiter, is computed to be nin millions of miles distant from the his annual revolution is performed twenty-nine and a half of our ye diameter is seventy-nine thousand m the deficiency of light occasioned b mense distance, renders it impossible this the exact time of his diurnal upon his axis. Seven moons or sat volve round the equator of this plan is also encircled by a luminous ring, occasioned many conjectures among of astronomy;—some supposing thi appearance to be produced from th

of the planet, calculated to give addi-
force and brilliancy to the rays of the
nd thus compensating to the inhabitants
ch there be) for the prodigious distance at
h they are removed from the grand prin-
e of light and heat.

lie GEORGIUM SIDUS discovered by Dr.
schel, and so named in honour of George
. the present king of England, but gene-
ly called Herschel after the discoverer. is
t discernible without glasses of considerable
ower; its distance from the sun being com-
uted at eighteen hundred millions of miles.
From the most attentive observation of its pro-
gress in different parts of its orbit, it has been
found to move through it in eighty-two of our
years, and it is supposed to be ninety times
larger than the planet which we inhabit. Six
moons have already been discovered to move
round it, and the remoteness of its situation
in respect to the sun, renders it highly proba-
ble that it has a still greater number.

CERES FERDINANDEA, so called in honour
of the tutelar patroness and the reigning
monarch of Sicily, was discovered on the
1st of January, 1801, by M. Piazzi, astrono-
mer at Palermo; and the planet PALLAS was
discovered on the 28th of March, 1802, by
Dr. Olbers, at Bremen in Germany Both of
these planets appear like telescopic stars of the
seventh or eighth magnitude; both of them
move in orbits between those of Mars and Ju-
piter; and it is a remarkable fact, that thei

orbits cross each other; the planet Pal
coming nearer to the sun than Ceres F
dinandea in the perihelion, or near part
their orbits, but removing to a greater d
tance than the latter in their aphelion, or f
ther part of their orbits; occasioned by t
great eccentricity of the orbit of Pallas co
pared with that of Ceres Ferdinandea. T
sizes of these planets have been different
stated by various astronomers, but Dr. H
schel computes the diameter of Pallas to
ninety-five, and that of Ceres, a hundred a
sixty-two miles: he also seems to consider th
of a different species from the other planets
the Copernican system; and has given th
the appellation of Asteroids, because they
semble the other planets and stars in the cle
ness of their light, while in size and moti
they bear an analogy to the comets T
periodical revolution of Pallas is four yea
eight months, and three days; and that
Ceres, four years, seven months, and ten da

HERCULES, recently discovered by I
Olbers, is three times the size of Jupiter, a
performs its revolution round the sun in t
hundred and eleven years: being 3,047,000,0

Having thus briefly described all the planets which have hitherto been discovered, together with their attendant moons or satellites, the comets are the only bodies belonging to our system which remain to be noticed. to which Thompson alludes in these beautiful lines:

"Lo! from the dread immensity of space,
Returning with accelerated course,
The rushing *comet* to the sun descends,
And as he sinks below the shading earth,
With awful train projected o'er the heavens,
The guilty nations tremble."

The number of the comets has never been ascertained; but from a series of observations it appears, that they revolve about the sun in elliptical orbits, and describe equal areas in equal periods. They are, also, solid opaque bodies of various magnitudes, like the planets, and are principally distinguished from them by long and fiery streams or tails, which continually issue from that side of them which is most remote from the sun. We cannot suppose, however, that they are the abodes of animated beings, as their very eccentric orbits are of such prodigious circumferences, that in their journey through the heavens, they sometimes approach so near the sun as to be almost vitrified, and then rush off to such immense distances in the region of infinite space, as to be *totally* deprived of light and heat.

The periods of the comets which h
observed vary from seventy-five to
dred and seventy-five years. The
these appeared in the years 1531, 1
1682, and was expected to return
venty-fifth year; and one conjectu
the same, was seen by Dr. Halley
The *second* was discovered in 1532 a
and was expected to make its ap
again in 1789, but in this, astronom
been disappointed. The *third* app
1680, and its period being computed
years, it consequently is not expecte
turn till the year 2255. This last
its greatest distance is supposed to b
thousand two hundred millions of mi
the sun; whereas its least distance f
luminary is but four hundred and nin
sand miles.

The tails or streams of fiery matter
from these bodies are evidently own
heat of the sun, and extend or shorte
approach toward or recede from that
ry. Their tails appear to be streams

composed of so subtle a vapour, that we can see them distinctly through it.

The apparent magnitude of the comets varies very considerably; as they sometimes appear only of the size of the fixed stars, and at other times equal the diameter of Venus, or even that of the sun or moon. It may also be remarked, that they have different phases like the moon, and sometimes lose their splendor suddenly, while their apparent bulk remains unaltered.

We must now turn our attention to the Fixed Stars, which are distinguished from the planets by being more luminous, and by continually exhibiting that appearance which is called their scintillation or twinkling: this may probably result from their appearing so extremely minute, that the interposition of the numerous small bodies which are perpetually floating in the atmosphere deprives us of the sight of them; but as these soon change their places, the stars are again visible: and this succession being perpetual, occasions the scintillation. Another remarkable property of the fixed stars, and that which first gave them a name, is their never changing their situation with respect to each other; for though the diurnal rotation of our earth upon its axis occasions an apparent motion of all the heavenly bodies, yet any two fixed stars observed at different periods of time, are always *found* to preserve the same relative *position.*

The stars are supposed, by unlearned
attentive observers to be fixed in a c
sphere; but this idea results from the in
extension of the universe, and the spe
viewing them from a sphere of light w
formed within his eye. Instead of beir
distant from our earth, the fixed stars ar
ably situated in very different degrees
moteness; and therefore, although ter
pressive of different degrees of magnitu
applied to them, according to their resp
appearances, we cannot venture to asse
they are not all of equal magnitude

Dr Herschel, whose laborious investi
are entitled to the warmest applause,
covered that the galaxy, or milky-wa
sists of an innumerable quantity of fix
and in the most crowded part of it he
served five hundred and eighty-eig
pass through the field of his large tel
one minute Hence he observes, that
the sun which regulates our system
centre of it with respect to us, we s
consider him as placed in the cen
ince our system may n
dth part

ns such as these are equally calculated
cite our admiration of the stupendous
ers of creation, and to call forth all our
; and all our gratitude to the illustrious
livine Architect, who spake and it was
who commanded, and it stood fast.

e disappearance of some stars, and the
n appearance of new ones is a phenon equally singular and difficult to be ac:ed for. A circumstance of this nature nduced Hipparchus to undertake the task mposing a catalogue of the stars, that e generations might become acquainted the state of the heavens at that period; ince his decease, both ancient and modern nomers have observed many changes of ilar nature. Some of the largest stars ɔt precisely occupy the situations mend by the ancients, and some others are vered to have a periodical augmentation decrease of magnitude. Arcturus and ; have been found to change their places oving two or three minutes of a degree rds the south, in a century: and Aquila Aldebaran have a motion of the same kind, ather slower and more difficult to be deined.

'all the new stars which have excited the ition of modern astronomers, the most reable was first discovered by Cornelius ma, on the 8th of November, 1572, and ved by Tycho Brahe on the 11th of the month. Its brilliance exceeded that of

Jupiter when nearest the earth,
amazingly strong as to be visible
time. But in the beginning of D
began to diminish, and gradually
till March, 1574, when it totally di
—Another new star was discover
scholars of Kepler, on the 10th o
1604, which was situated in the ri
Serpentarius, and shone with a sple
inferior to the former; but, after
gradual diminution, it disappeared
beginning of January, 1606. Neith
stars had any parallax or apparen
whence it is evident they must hav
more remote from the earth than a
planets, and they had no hair nc
afford a supposition of their being

Various conjectures have been
specting these phenomena: but o
most probable is, that if a star by
volution be made to assume a flatte
and it have a rotation on its axis
that of our earth, its brightness mu
rily be less when its edge is pres

[redacted] actually wonderful in itself, and [redacted] to inspire our minds with the most [redacted] and extensive idea of the works of [redacted]. Sirius, or the dog-star is known [redacted] the nearest to us, and yet such is the [redacted] of its situation, that although the [redacted] in performing its revolution round the sun, is a hundred and ninety-five millions of miles nearer to it in one part of its orbit than in the opposite one, there is not the least apparent diminution of its distance, or augmentation of its magnitude. Some astronomers, indeed, have supposed that there might be stars at such astonishing distances in the vast immensity of space, that their light, though allowed to travel at the rate of ten millions of miles in a minute, has not yet reached the earth since the time of its creation.

The *ecliptic*, which now demands our attention, is an imaginary great circle in the heavens apparently described by the sun in the course of a year, and marked on the celestial globe with a red line, as emblematic of the cheerful heat communicated to us by that body. The sun, indeed, seems to have a circular motion in the heavens every day, which may be observed by the most careless spectator; but its course annually, and which cannot be understood without much attention and patient observation.

There are two methods by which the circle of *the ecliptic* in the heavens may be

traced with a tolerable degree of pr
viz. by observing several remarkabl
stars to which the moon seems to a
in her course; or otherwise, by ob
the situations of the planets: for altho
moon be not always exactly in the ecl
is sure to be within little more than
grees of it, on one side or the other;
planets are always within eight degree
line of the ecliptic.

CHAPTER III.

Of the figure of the Earth; its diurn annual motions, &c .....Different len Days and Nights; and vicissitudes Seasons.

THE planet which Infinite Wisd ordained for the residence of mankin in ancient times, considered as a vast plane, extending on all sides to an i

time of Gallileo, that a sanguinary inquisition would assuredly have doomed that astronomer to a cruel death, had he not solemnly abjured his *impious* and *heretical* doctrine of the sphericity of the earth. Happily, however, for mankind, the discoveries of a Columbus silenced the senseless clamour of the Romish clergy; and the figure of our globe, together with its motions annual and diurnal, are now explained in so clear and perspicuous a manner, that a competent knowledge of them, may be attained with the utmost facility by every attentive reader.

The figure of the earth is an oblate spheroid, or in the shape of an orange, the diameter from pole to pole being about 37 miles shorter than that at the equator, and with this small difference it resembles the artificial globe; for the mountains, valleys, &c. which might be considered material objections to its rotundity, are, in reality, scarcely equivalent (in proportion to the bulk of the earth) to the smallest protuberance on the surface of an orange, or to a grain of dust on an artificial globe twelve inches in diameter.

The veracity of this doctrine, without recurring to scientific investigations, was fully demonstrated by the voyages of those famous navigators, Magellan, Sir Francis Drake, Lord Anson, and Captain Cook, all of whom set out at different periods to sail round the world, and by steering their course continu-

ally westward, retur
place whence they h
The rotundity of
proved by our own
son stand by the sea
water, and a vessel
siderable distance,
top of the mast,
the hull of the sh
vessel be going
loses sight of th
at last can bare
top of the mast
prove that th
sents an impe
object; as ot
being the lar
pear first in
in view, in
Another
afforded b
the moon
body hav
from the
interpos
necessi
and as
total,
a circ
whic
ical

, which however, were
n their true meaning; as
nspired writers accommo-
neir expressions to general
the common ideas of the
their grand business to nar-
ers of fact, and to render
) salvation, rather than to
. the curious phenomena of
us when we read of the sun
his race, or perüse the ac-
s success while the sun stood
on and the moon in the valley
should recollect that this was
nage which could be generally
the people; and even at the
stronomers themselves speak of
and setting, not as a matter of
the appearance occasioned by
the earth, which will now de-
ntion.

well known, and now generally
t the earth turns on an imagi-
ry twenty-four hours, and, by
daily motion, causes the alter-
n of day and night: for although
and stars, *appear* to rise in the
n the west, that appearance is
asioned by the earth turning the
. Thus children travelling ra-
ach or post-chariot, or sailing
iver, are induced to suppose that
ges, banks, or other objects are

running away in a direction exactly oppo
to their route. And if it be urged, as an
jection, that we are unable to *perceive* any
tation of the earth, notwithstanding the
pidity with which it is supposed to move,
reply—that as our globe is not impeded
any resisting obstacles, its motion cannot
communicated to the senses; and as an il
tration of this remark, it may be added, t
vessels on a smooth sea are sometimes tur
completely round by the tide, without
knowledge of the mariners or passengers
happen to be employed between decks, o
the cabin.

It has been asserted by the enemies of
Copernican system, that if the earth perfor
the diurnal rotation we have spoken of, a st
dropped from the top of a high tower, or
considerable elevation, would not fall
pendicularly, as the building or eminence
have advanced considerably during the
but it may be easily demonstrated, by a va
ty of experiments, that a body projecte
impelled from another body in motion, i
riably partakes of the motion of that bo
thus an apple may be thrown up and ca

several feet while
ie air.
al rotation of the
ie regular succession
e apparent motion of
as another, called its
. on which depend the
ons, spring, summer,

ssive motion may be
1 attentive observation
: for as the sun's appa-
he earth, in the course
o west, may be referred
1 of the earth upon its
irection; so likewise his
lution in the heavens, and
g continually in different
be referred to that motion
orbit which it completes in

ed that the alternate succes-
night results entirely from
n of the earth upon its ima-
l this will appear sufficiently
onsider it with even a mode-
tention. For as the earth per-
e rotation every twenty-four
y half of it can be illuminated
ecessarily follows that any par-
of country must sometimes be
ls the sun and sometimes from it,
such tract must experience

regular succession of light
as long as any given place
the illuminated hemispher
cheering influence of day,
round by the earth's diurn
involved in the shades of n

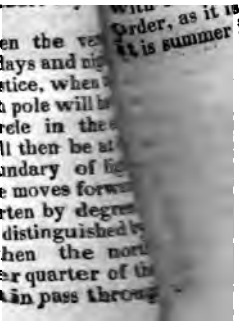
As only one hemisphere
at a time, that circle wh
of light and darkness is ca
and it is obvious that if th
perpendicular to the pla
terminator would pass thr
divide into two parts each
which are parallel to the
regular motion of the ea
every place to describe
of these circles in equal
days and nights would of
all parts of the globe, ex
where the sun would not a
or set, but would perpetua
horizon.

But if the earth's axis
plane of its orbit, the ter
all the parallels except th

their nights longer than their days, and
equator the days and nights will be
ually equal.
be inclination of the axis be reversed,
rminator will still divide the parallels
equal parts, but the phenomena will be
y the contrary; for all places under the
rn parallels will have their days longer
heir nights, and those which lie under
rthern parallels will have their nights
than their days; whilst the days and
at the equator will be equal as before.
s the greater disproportion is in the
latitudes, it is obvious that in either of
positions of the globe, all places lying
the poles, must have either a constant
r perpetual night: the diurnal motion
earth never carrying them into the op-
hemisphere.
se observations, if considered with at-
, will enable the young reader to ac-
for all the variations in the length of
nd nights, and the vicissitudes of sea-
sulting from them.
astronomical plates the four different
ns of the earth in her annual revolution
the sun, are distinguished by the months
rch, June, September, and December.
as the axis of the earth is always di-
to nearly the same point in the heavens,
t constantly retain the same position,
; always in a situation nearly parallel,

nator will pass through the poles,
equal days and nights all over the
when the earth is carried further i
the north pole of the axis, still
the same parallel situation, will ac
the illuminated hemisphere, and ir
be about twenty-three and a h
from the terminator, the south po
the same distance in the dark hemi
this month, therefore, the northe
the globe will enjoy long days ar
whilst the opposite parts have sho
winter.

During the interval between
equinox, or the time of equal days
in March, and the summer solstice
day is longest in June, the north po
described one quarter of a circle
lightened hemisphere, and will th
utmost distance from the bounda
and darkness: and as the globe mo
in its orbit the days will shorten
till it arrive at the position disti
the month of September, when
pole having described the other q
circle, the terminator will again



plated calendar, is too ob
lustration; as it is this w
ascertain the precise retur
seasons; to direct us in the
of agriculture; to regulate
our civil and ecclesiastical i
transmit the dates and part
ble events to succeeding ge

It has, therefore, been or
cares of every society of me
uniform method of computi
the modes adopted in differe
equally various and uncerta

The Egyptians are supp
fixed the length of the year,
sist of 360 days, which t
twelve months, that it migh
course of the moon. Fiv
added by Mercury Trismeg

...t of January; the Mahometans commence ...ith the day when the sun enters Aries, or ...e ram; the Persians in the month answer... to our June; the Indians and Chinese ...ith the first new moon which occurs in ...arch; and the Mexicans, on the 23d of ...ebruary, when their country first exhibits a ...erdant appearance. It is also worthy of ob...ervation, that the first and last days of the ...ear among the Romans, were consecrated to ...anus, which probably may account for that ...eity being invariably represented with two ...aces.

The division of time into weeks is, also, of very great antiquity, and in most countries the week has been made to consist of seven days, supposed to have been derived from the tradition, of the creation of the world. This measure however, was not universally adopted; for the week of the ancient Greeks is said to have consisted of ten days, and that of the Romans of nine; though the latter nation afterwards divided it into seven days, viz. Dies Solis, Lunæ, Martis, Mercurii, Jovis, Veneris, and Saturni, which were the names of the sun, moon, and planets. And the English have closely imitated this example, for Saturday Sunday, and Monday, clearly signify, Saturn's day, the Sun's day, and the Moon's day; while Tuesday, Wednesday, Thursday, and Friday, are the days of Tuesca, Woden, Thor, and Friga, which are the Saxon appel-

lations of Mercury, Mars, Jupit
nus.

The length of the year was regu
the Greeks and other ancient nat
moon which they considered the
of any of the heavenly bodies
pose; and as one of her lunati
tions round the earth was comple
29 and a half days, and twelve lu
supposed equal to one revolution
their months consisted of 29 and
ternately, and their year of 35
as the interval between two full
ascertained to be 29 days, 12 ho
utes, and 3 seconds; and as th
365 days, 5, hours, 48 minutes, a
to mov[illegible] one of the solstitial
same p[illegible]; this computati
been v[illegible]ve, as there is a
more than [illegible] days between
the tru[illegible]ar.

Inc[illegible] the defects of the anc
were [illegible]s, that they affo
of ri[illegible] the Greek comedies
seve[illegible]maticians to propos

, to the most extraordinary qualities as a rior and a statesman, added an intimate wledge of astronomy and the mathema- . Assisted by Sosigenes, an Egyptian hematician of great celebrity, he soon overed that the division of time must de- d entirely on the annual revolution of the ; and as this was found to be completed 65 days, and about 6 hours, he made the r to consist of 365 days for three years suc- sively, and inserted an additional day every rth year, in order to take the remaining ours.

In addressing one of the priests on this im- tant reformation, he said, "I expect that doxus will not, in future, be more famous the ephemerides which he gave to Greece, his return from Egypt, than I shall be by order to which I have reduced the course the year." The result justified his sanguine pectations.

This reformation was adopted about forty- years before the Christian era; and as ety days, computed to have been lost by former mode of reckoning, were now en into the account, the first Julian year sisted of four hundred and forty-four days, l was aptly termed *Annus Confusianis*, or year of confusion. Thenceforward the r was made to begin on the first of January, l each of the months, excepting Februa- was made to consist of thirty or thirty- days, in order to preserve the greatest

possible regularity among the mon
render them nearly equal to the lun
which consist of about twenty-nin
a half. That the odd six hours w
ready mentioned, might not be los
tional day was introduced every fo
by reckoning the 24th of February t
and as this day was the same as th
the calends of March, in the old cal
celebrated on account of Tarquin's
it was termed *bis sextas calendas*, w
English have derived their appella
sextile or Leap-year.

In compliment to Julius Cæsa
rendered such an important serv
commonwealth, the month Quintili
he was born, was changed to Juli
mand of Mark Antony: as the n
the month Sextilis was afterwar
to Augustus, in honour of the rei
peror.

But, although the reformed cal
obviously superior to any precedi
was still imperfect, having been
the supposition that the sun co
apparent annual revolution in e
days, 6 hours, instead of 365 days
48 minutes, and 49 seconds: and
evident, the civil year must have
the solar one (according to this co
by 11 minutes, and 11 seconds, wh

47,450 years, would have occasioned a complete revolution in the seasons, so that the summer solstice would have fallen in the depth of winter, and the landscape would have been covered with snow when it was expected to be enamelled with the richest tints of Flora.

Notwithstanding this incorrectness, the Julian calendar was universally adopted by the European states, and some of its effects were traced and exposed by our countrymen, the venerable Bede, Sacro Bosco, and Roger Bacon, who have justly been styled ornaments of the age in which they lived. These celebrated characters discovered that the true equinox preceded the civil one, and, having found the cause of it, they calculated that from the council of Nice, when the vernal equinox was fixed, A. D. 325. to the year 1582, the error had accumulated to ten days, so that the vernal equinox now happened on the 11th of March instead of the 21st. as it would have done, had the Julian account corresponded with the sun's annual revolution.

The constant anticipation of the equinox was first submitted to the councils of Lateran and Constance by two cardinals, who demonstrated its cause and explained the method of correcting it; and so perfectly was pope Sixtus IV. convinced of the necessity of a further reformation, that he bestowed the archbishopric of Ratisbon on Regiomantanus an eminent mathematician, in order to engage

egorian Account, or ...
adopted in most parts of Europe.
render the length of the year more ex-
conformable with the apparent motion
sun, the reformers agreed that the ten
which had been gained by the Julian
unt should be cut off from the month of
ober in the year then current, so as to
g back the equinox to the 21st of March,
t had been fixed by the council of Nice ;
. to prevent future variations of a similar
ure, it was determined that three days
ery four hundred years should be omitted,
in other words, that instead of making
ery hundredth year a bissextile, as formerly,
ery four hundredth year only should be
sidered as a bissextile, and the others be
...on years.

...ment, equally simple and
...lar year and

es, the error resulting from the old
l consequently be corrected, and
putations, on this plan, would not
the true time in less than eight or
nd years.

vithstanding the obvious superiori-
Gregorian or new calendar, it was
opposed by many Protestant
om their inveteracy against the
rity; and in various parts popular
were found insurmountable, while
iduals, even votaries of science
illed in the mathematics, attacked
ode of reckoning with the utmost
nd proposed other methods which
ed less exceptionable. In process
wever, its excellence was pretty
en and allowed; and in the year
admitted into the English calen-
act of parliament, obtained for
e. But as a hundred and seventy
lapsed since the Gregorian refor-
upwards of a whole day had been
the course of the sun, it was or-
instead of cancelling ten days, as
ly been done by pope Gregory,
should be left out of the month of
Accordingly the old style ceased
f that month, and the ensuing day
he 14th instead of the 3d.

HAVING endeavoured to show
of the diurnal and annual mot
habitable globe, and having ex
vicissitudes of the seasons as result
annual revolution of the earth, co
the inclination of its axis, we now
consideration of the equation of t
elucidate the difference between
parent time.

Astronomers have discovered t
apparent journey through the he
unequal, and consequently mean
which flows on perpetually in th
ner, cannot be accurately meas
motion of the sun.

Mean or equal time is measu
regulated clock or watch; and
is measured by the sun's appare
the heavens, or by a good sun-

perihelion, or nearest to the sun; and slow
when in aphelion, or most remote from t
luminary.

The rotation of the earth is the most eq
ble and uniform in nature, and is perform
in 23 hours, 56 minutes, and 4 seconds; wh
space of time is termed a *sidereal* day, beca
any meridian of the globe will revolve fr
a fixed star to that star again in this peri
But a *solar* day, intended to be measured
our clocks and watches, is the time which
meridian on the earth will take in revolv
from the sun to the sun again, which is ab
twenty-four hours.

If the reader inquire the cause of the
erence between this solar and sidereal d
it may be replied: The distance of the fi
stars is so immense that the diameter of
earth's orbit when compared with it, i
mere point; and consequently any given
ridian on our globe will revolve from a fi
star to that star again, in the same poin
time as if the earth had only a diurnal mot
and never changed its situation in its or
But with regard to the sun, the earth
vances nearly a degree eastward in its or
in the same time that it turns round its a
and hence it must of necessity perform n
than a complete revolution before it can c
into the same position with the sun tha
had the preceding day.—To illustrate this
suppose both the hands of a watch or

piece to set off together, at 1 o'clock, bu
are perfectly aware that the minute-hand
describe more than a complete circle bef
can overtake the hour hand, or, in other w
before they will again exhibit the same
tive position.—Thus it is evident from obs
tion, that the sidereal days are shorter
the solar ones, by about four minutes.

The reason of the difference betw en
dials and clocks or watches, next dem
our attention —A good time-piece of an
scription is designed to measure the equa
uniform time exhibited by the rotation o
earth on her axis: but a sun-dial mea
time by the sun's apparent motion, whic
have already shown to be subject to varia
Or to state the case in another point of v
—the earth's motion on its axis is perf
regular, and the rotation of the equator
plane of which is perpendicular, to the
is likewise uniform; yet the length of
natural day is always measured by mea
the sun, whose apparent annual motion i
in the equator, but in the ecliptic, whi
oblique to it.

It may here be necessary to remark
pressly, that the earth's equator, is not al
directed towards the centre of the sun, du
her annual revolution; but twice only in
year a line drawn from the centre of the
to that of our globe passes through the p

respect... to vary ...
perceived to vary ... that *equal* portions of the ecliptic (or, that *equal* portions of the ecliptic, in consequence of its obliquity) pass over the meridian in *unequal* portions of time.

The *unequal* points of time may be measured by a sun-dial, may be represented by the artificial globe by equi-distances on the ecliptic; and that measured by those on the equator. If the globe be turned on its axis, all the points in the first quadrant of the *ecliptic*, viz. from Aries to Cancer, will come sooner to the meridian than their corresponding points in the *equator*: those from Cancer to Libra will come later:—those from Libra to Capricorn sooner:—and those from Capricorn later. Hence it appears, that while the sun is in the first and third quarters of the ecliptic, while our globe is travelling from Capricorn to Aries, ... while

September, and likewise at the s
winter solstices, which happen o
of June and the 21st of Decembe
apparent revolution of the su
times is parallel with the equato
have already premised that the e
of the earth's orbit was another
variation between the sun-dial an
watches.

Supposing the orbit of our glob
cular, its motion would be equab
whole difference between *mean* a
time would be occasioned by the
of the earth's axis. This, howe
trary to the fact, for in winter,
est the sun, the earth travels upw
gree in twenty-four hours, and
when farthest from the sun, it a
than a degree in the same space of
this cause, therefore, the natural
be longest when the earth was
sun; as it must continue turning
time after a complete revolution,
meridian of any place to the sun

mean or equal time: for although
own by a sun-dial may be deemed
atural, it is in reality of no other
it may be employed in discovering
me, to which all the celestial revo-
d every chronological epoch are
referred
ation of time seems to have been
as early as the time of Ptolemy,
nployed by those celebrated astro-
epler, and Tycho Brahe; but it
em to have been adopted by many,
mstead published a dissertation up-
e end of the works of Horrox.
s place and anom ly being subject
l variations, it is impossible to con-
general equation tables, so as to be
but the following table, which we
l, with a few alterations, from that
aton, and which is adapted to the
r after bissextile, or leap-year, will
ound within a minute of the truth;
se, is sufficiently accurate for the
of clocks and watches, which are
d into minutes.

A TABLE OF THE

EQUATION OF TIME.

Months.	Days.	Equ. in Minutes.	Months.	Days.	Equ. in Minutes.	Months.	Days.	Equ. in Minutes.	Months.	Days.	Equ. in Minutes.
Jan.	1	4*	Apr.	1	4*	Aug.	9	5*	Oct.	2	
	3	5		4	3		15	4	Nov.	1	
	5	6		7	2		20	3		2	
	7	7		11	1		24	2		2	
	9	8		15	0		28	1		2	
	12	9		*	—		31	0		3	
	15	10		19	1†		*	—	Dec.		
	18	11		24	2	Sep.	3	1†			
	21	12		30	3		6	2			
	25	13	May	13	4		9	3			
	31	14		29	3		12	4		1	
Feb.	10	15	June	5	2		15	5		1	
	21	14		10	1		18	6		1	
	27	13		15	0		21	7		1	
Mar.	4	12		*	—		24	8		2	
	8	11		20	1*		27	9		2	
	12	10		25	2		30	10		2	
	15	9		29	3	Oct.	3	11		*	
	18	8	July	5	4		6	12		2	

CHAPTER VI.

Latitude and Longitude, with the methods of ascertaining them.

E inventive powers of the human mind stimulated by curiosity, or drawn forth cessity, have frequently demonstrated, ew things really beneficial to mankind laced beyond the reach of discovery. dea of determining the true place of a n the ocean, would, in former times, have considered chimerical and absurd; but sible as the solution of such a problem appear then, it is now well known that e aid of a quadrant and a few books the er can inform himself. with tolerable ion, of the situation he is in; and can certain how far he has proceeded on his e, and in what manner he must direct urse to arrive at the place of his desti-n.

those purposes it is only necessary to dis- the latitude and longitude of the places consideration, as when these are ascer-l, the places themselves may be readily on a common map or globe. The true t of these terms, therefore, and their ap-ion to the above-mentioned purposes, rm the subject of the present chapter;— ect equally important in itself and inte-g to the contemplative mind.

The *Latitude* distance north line; and the *L* west of the *me* celestial object i from the *ecliptic*; from that circle through the first

This subject h rily explained w poles of the eart dian, which con tention.

By the *poles* o extremities of he the imaginary li her diurnal rot face; that whic northern point north pole, and the south pole, site, and never a

The *equator* i drawn exactly i and separating hemisphere. N

tremely populous; and it is also known that the bleak and severe regions about the pole are not wholly desolate.

A *meridian* is an imaginary great circle which passes through the poles, and divides the eastern from the western hemisphere: and as any given place lying eastward or westward of another, may have such a circle drawn through it, there may consequently be as many meridians as there are places in different parts of the world. The meridian of any place is known by its being that circle in which the sun is invariably found at noon, or when he is equidistant from the point where he rises and that where he sets.

Having thus briefly explained the nature of the great circles connected with our subject, it is hoped our subsequent observations will be clearly understood.

The equator being considered as a line of separation between the northern and southern hemispheres, the latitude of a place is its distance north or south from this boundary; and it is said to have north or south latitude, according as it lies in the northern or southern hemisphere: the latitude of any place will therefore be greater or less according to its remoteness from, or proximity to, the equator. And to ascertain this distance, we suppose a meridian to be drawn through the given place, and by counting the degrees of that circle contained between this point and the equator, we

by the latitude being expres
minutes, and how the distanc
lar place from the equator
them. Thus, if a tract of c
have 90 deegrees north lati
course, lie under the north p
90 degrees of south latitude, i
under the south pole. And l
any place which has 45 deg
south latitude, must be equi
equator and the north or sou
also, it will appear, that unde
latitude is nothing, but that
creases as we approach eith
where it is 90 degrees, the gre

The latitude of any place n
ed by the help of a quadrant

ay altitude; and in all places that lie
ard of the torrid zone; the sun is ex-
outh at noon, which enables the mari-
ascertain the other points of the com-
or if he turn his face to the sun at noon,
th point will be exactly behind him,
st on his right hand, and the east on

e take the altitude of the sun or a star
meridian, and either of those objects be
equinoctial, that altitude subtracted
) degrees will show the latitude of the
but if the sun be not in the equinoc-
will be necessary to subtract its decli-
if north, or add it if south, from or to
grees of altitude; and the remainder or
ibtracted from 90 degrees, will give the
e. Those persons, indeed, who have
ery slight knowledge of the celestial
may form a tolerable idea of the lati-
any place by merely looking about
For if the sun be over their heads at
hey may know themselves to be within
opics, and on the contrary, if it either
ie up 24 hours, or never rise during that
hey are within the polar circles.

situations of the poles are easily point-
in the heavens, as they are those points
appear as centres of revolution to the
their apparent diurnal motions. Sup-
a spectator situated on the equator,
he north and south pole will be in his
n: *or if he recede* from that line one of

the equator, he concludes ...
ern latitude, if the celestial bo
rise on his left hand, and set on
but if they rise on the right and se
he knows himself to be in the sou
phere.

But as many different places n
same latitude, it is evident that t
ment of this particular alone is
to enable us to fix the exact situ
place, either on sea or land. We
discover the parallel under whic
its distance from the equator;
can fix its accurate position in
and refer to it upon a map or gl
find the distance of the place f
meridian, as well as its distance
tor; and as no particular circl
distinguishable from the others,

', the distance of any place may be
om it in degrees, minutes, &c.
ners and geographers seem to have
y embarrassed in their choice of a
an, and even at present they are
in their determination, but gene-
on that on which the metropolis of
country stands. The Dutch, how-
some other nations, consider the
neriffe as the most proper situation
pose; and the English make their
an pass over Greenwich, on ac-
e Royal Observatory being at that

ing further upon this subject we
, the practice of our countrymen,
; the longitude of all places to the
Greenwich, and this of course is
lered by our juvenile readers as the
an.

idian cuts the equator in two op-
nts, at the distance of 180 degrees
; and as the equator is the line
des the northern from the southern
, this circle may be considered as
separation between the eastern and
n hemispheres. The affinity be-
e circles is, also, observable in ano-
cular, for as the latitude of any
e is its meridional distance from the
o the longitude of that place is its
distance from the first meridian.

.ce being g... tance east or west from ... order, however, to obtain an accurate ... this distance, it is necessary to conceive ...eridian drawn through the given place, a ... reckon how many degrees of the equa ...re contained between this and the first m ...lian; which will enable us to judge of ...situation of the place with respect to its ... gitude.

But as this method, in which the merid ... are considered as entire circles, is subject ... some ambiguities, it is more advisable to ... sider them only as semicircles, drawn fro ... pole to the other: for as, by this mod ... equator may be divided into 180 degree ... way from the first meridian, and none ... semicircles can intersect it in more poin ... difficulties will be avoided, ...ared with the

: and that the longitude of any
the first meridian is accounted

'e previously observed that many
he same latitude, so it is equally
great number of different places
e, have the same longitude; for if
ı meridian to be drawn through
on the globe, all places under that
ien referred to the equator, will be
'om the first meridian, and their
ll, of course, be the same.
fore sufficiently obvious, that our
f the longitude of a place only
)le us to fix its precise situation,
an our mere knowledge of the
/ this means, we may tell under
n a place lies, and what is its
itance from the first meridian;
to find its exact position on the
ust ascertain both the meridian,
lel of latitude of the given place;
vhere these circles intersect each
true situation of the place under

longitude of any particular place,
:rve the hour in that place, and
.t hour it is at some distant part:
must have from some exact time-
) the time of some other place, or
rvation of the heavenly bodies;
: eclipses of the moon or of Jupi-
i are best calculated, as the com-

ing on of these eclipses is seen a
stant of absolute time from the
of the globe to which they a
their relative time will vary ac
difference of longitude.

Now the times of these appea
culated according to a certain
these calculations are given in
or ephemeris; so that by att
time of the coming on of the ecli
to our distance east or west fro
so will the hour of its appeara
that of the calculation; but the
time between any two places
name for their difference of l
all places lying under one mer
same longitude, and experienc
same hour of the day, and th
time between any two places
distance of their meridians from

But as eclipses of the moon h
dom to be of much utility at se
of Jupiter's satellites are not
a telescope, the effect of which

red extremely easy, as such an instru-
uld enable us to discover our meridian
art of the globe. For we should, in
e, only have to find when the sun
o the meridian of the place, or when
xactly south; and then knowing it to
ctly twelve o'clock, we might compare
me thus found with that shown by the
, and by turning the difference into de-
and minutes, we should ascertain the
itude required.

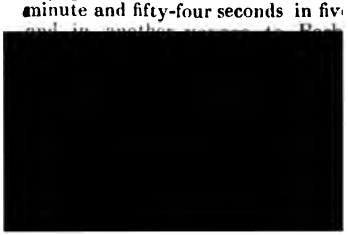
or illustration of this;—suppose an indivi-
l residing at St. Petersburgh, in Russia,
nes to ascertain the longitude of that city
m London. He perceives when the sun
nes to the meridian, that it is exactly 12
lock at that place, but on looking at his
tch, which shows the time at London, he
ceives that instead of being twelve o'clock
that, it is only fifty-eight minutes and
ty-three seconds past nine. He therefore
ncludes that when it is noon at St. Peters-
rgh, it is before noon at London, and that
e difference is two hours, one minute, and
renteen seconds; which by allowing fifteen
grees to an hour, answers to thirty degrees,
neteen minutes, and fifteen seconds; and as
e noon arrives so much sooner at Petersburgh
an at London, he knows the longitude of
e place to be thirty degrees, nineteen min-
es, and fifteen seconds, east of London.

With the same facility might the longitude
all other places be ascertained, provided

the watch or time-piece used for th
were perfectly free from irregular
always showed the exact time as it
found at the same instant in Londo

All pieces of mechanism, howev
liable to injuries from a variety of c
so apt to be affected by the motion
ling and the different temperature
mosphere in different climates, th
unreasonable to expect any time-kee
or clock, to be brought to a state of

Much more than could have beer
has, indeed, been done in this way b
genious and excellent artist Mr. Jo
son, whose unwearied studies and inc
exertions appeared so deserving of e
ment, that the Commissioners of
allowed him several sums of mone
might be enabled to bring his imp
signs to perfection. A watch whic
in the years 1761 and 1762, was
trial to Jamaica, and in the cou
voyage it was found to have varie
minute and fifty-four seconds in fiv



thirty miles, or half a degree of a great circle; fifteen thousand pounds if it came within two thirds of a degree, and ten thousand pounds if it came within one degree of the truth.—The same ingenious artist some time afterwards explained the principles of his time-keepers, so as to enable others to make them with the same accuracy: and received, for his communication, the remainder of the parliamentary reward.

Whilst Mr. Harrison was prosecuting his important design at home, Messrs. Berthoud, Le Roy and others, devoted their time to the same object in France, and produced several time-keepers which proved worthy of the highest commendation. Messrs. Kendal, Arnold, Mudge, and other English artists of celebrity, have also made some considerable improvements in this branch, and produced many chronometers, which are deservedly held in high repute. The greatest remuneration, however, which can now be obtained for the true discovery of the longitude, is ten thousand pounds, and, according to an act passed in the year 1774, all time-pieces which may, in future, be offered for that purpose, must undergo the most rigorous trial.

But if a watch or time-keeper of this description cannot be procured, we have another method afforded us, which, though confessedly attended with some difficulties, is that in which astronomers have the greatest confidence:—*This method is* derived from observing the

oon, at any time when she is visible above
ne horizon of the place where the observation
s to be made.

It is known, that the moon rises about three
quarters of an hour later every day than upon
the preceding one, and as the change of her
situation, from day to day, among the stars,
considerable, those changes are admirably
suited for pointing out the longitude. If,
example, the moon be seen near any fi
star this evening; on the morrow at the
hour she will be found to have removed
considerable distance from it toward the
and this motion, which is sometimes upw
fifteen degrees in a day, will conse
serve to denote any small portion of
nonding time. So that if a mariner
ely the time, and the distan
fixed star, and als
on of Greenw

nce either between the sun and moon,
oon and some particular fixed star.
iurnal motion of the moon in her orbit
thirteen degrees, and her hourly mean
s half a degree. or about one minute
ree in two minutes of time. It must
be sufficiently obvious, that the com-
of an error of only one minute in a
on of the moon's place, will occasion
of two minutes in time, or half a de-
ongitude Other errors are also very
ocur from the observation itself, and
ument used: for the most careful ob-
annot assure himself that he has as-
d the lunar distance within less than
inute of the truth, and this joined to
ve mentioned error, will occasion in
le a mistake of three minutes in time,
quarters of a degree of longitude.
eater degree of accuracy, however,
expected, if the lunar distance be
om two stars, or from the sun and a
each side the moon when an opportu-
afforded; for as the imperfections of
rant, and the unavoidable inaccura-
ndant on the use of it, are observed
t each other, the mean result of the
observations may be relied on with
confidence, than either of them taken

lebrated Dr. Halley first demonstrated
rior excellence of determining the
by this method: but to the indefat

gable exertions of Dr. Maskelyne must be attributed that perfection to which it is now arrived: that gentleman having rendered the most important service to astronomy and navigation by the publication of his Nautical Almanack, in which the distances of the sun from the moon, and from certain fixed stars, are ready computed for every day for the meridian of Greenwich, with rules for ascertaining the time answering to any given distance. The public are also indebted to the same learned and ingenious gentleman, for "Tables requisite to be used with the Nautical Almanack," containing the names and situations of the brightest fixed stars, together with the mode of obtaining their precise distances from the moon at the time of observation.

CHAPTER VII.

Of the Moon, its Size, Phases, change[s] [illegible], Harvest Moon, [illegible]

, which makes a lunation: but she
etes her orbit from one point in the
ens, or from a particular fixed star, to
a point or star again, in twenty-seven days,
ven hours, forty-three minutes, and four
conds, moving at the rate of about two thou-
nd two hundred and ninety miles an hour.—
he diameter of the moon is two thousand,
ne hundred, and eighty miles, and her dis-
nce from the centre of our earth, about two
ndred and forty thousand miles.

The moon is said to be at the *full* when (our
rth lying between it and the sun) all the
nlightened part of it is visible it is at the
nge when, being between us and the sun,
s illumined part is turned from us; and it is
rned *half moon* when being half way be-
ween the other two positions, we see but half
ne enlightened part.

As the light of the sun is reflected on our
rth by means of the moon, so if that satel-
te be inhabited, our earth performs the same
eneficial purpose in return. It has been ob-
rved, that before and after the change of
ne moon, when it is only visible a little
hile in the morning and evening, its whole
dy may be seen distinctly; and at such
mes, one side of it resembles a bright slender
escent, but the greater part seems of a very
rk hue. "The bright part," says Mr. Wal-
er, "*is as* the day light of the moon; the
rk *part as* the moon-shine reflected from our
th."

It is asserted that in Italy, and some o
countries, where the air is peculiarly cl
the dark moon, or the moon at the cha
is visible when it rises or sets with the
a circumstance which must be occasioned
the light reflected from our globe, whic
that period is a full moon, and affords thir
times as much light as we receive from
satellite when at the full. Allowing thi
be the case, it appears that the inhabitant
the moon, if such exist, have a full moon w
we have change, and a waxing when we h
a waning one, all their lunar seasons b
the reverse of ours. It may also be
marked, that as the moon turns only c
round on her axis while she performs her
bit, one side being always turned toward
earth, must consequently receive two w
of moon-light from the earth, and two w
of sun-shine successively; the other side
maining two weeks in darkness, and an e
space in constant day. The day and ni
therefore, must be a month in length;
from the inclination of the moon's axis to
ecliptic, she can experience scarcely any

[redacted] year is supposed to be of the same absolute length both to the earth and moon, though they differ very materially as to the number of days; the lunarians having only twelve, while we have three hundred and sixty-five.

The moon is sufficiently near our globe to enable us to observe, even with the naked eye, many inequalities on her surface; and, by the aid of telescopes, astronomers have distinctly discovered them to be mountains and valleys, land and water, to which geographical names have been given, after the countries, seas, and islands of our earth, though without regard to figure or situation. Even the heights of some of these mountains have been calculated by means of the shadows projected from them on the moon's surface: and the great astronomer, Herschel, whose telescope magnifies six thousand five hundred times, has discovered three volcanoes in this planet. The principal one at the time of observation was in a part of the moon's disk not then enlightened; but it appeared to be about three miles in diameter, and illuminated the hills in its vicinity, whilst it ejected great quantities of smoke and burning lava. The other two seemed either to have been recently extinguished, or to threaten an immediate eruption.

Various arguments have been adduced for and against the probability of the moon having an *atmosphere*; but the discoveries of Dr.

Herschel, and the attentive observat
other astronomers seem to determi
question in the affirmative; as streaks
have been seen to dart instantaneous
different places in the moon at the ti
solar eclipse, which have been taken fo
ning, and which seems to evince not o
existence of a lunar atmosphere, but
ing similitude between the moon a
earth

In the motion of the moon we m
ceive a slow continual change, which
extremely minute, seems to evince t
present order of things must come to
It is a known fact, that the moon no
pletes her period in less time than fo
approaching nearer to the earth, an
sooner round it. Hence, eclipses wh
curred several centuries ago, appear f
accounts given by ancient historians,
happened differently both in time an
from what the calculations founded u
astronomical tables make them to hav

Thus the solar eclipse predicted by
to happen in Asia in the fourth year
forty-eighth olympiad, 585 years before

as Babylon, and to have gone down central over that city.

In like manner, the eclipse of the sun said to have happened on a summer's day in the first year of the Peloponnesian war, B. C. 431, to have been central to Athens about six o'clock in the evening; and to have gone down about Jerusalem, would, by calculations from the tables now in use, appear to have extended no farther than the ancient Syrtes on the African coast of the Mediterranean.

As the moon's motion on her axis is perfectly uniform, completing one revolution in the course of a lunation, our globe would be constantly over the same meridian of the moon, if the motion of that satellite in her journey round the earth were also equable; but she, like the other planets, is observed to move in her orbit with different degrees of velocity, and this occasions what is termed the libration of the moon, and the successive exhibition and disappearance of her opposite limbs or margins. When her motion is quickest, we see rather more of her western side; when slowest, a little more of her eastern side is presented to view. And as the moon's axis is rather inclined to its orbit, and preserves its parallelism round the earth, we sometimes see one of her poles, and sometimes another, which causes her to have an apparent wavering or vascillatory motion.

We must now turn our attention t
phenomena of the Harvest Moon, whi
particularly worthy of consideration.

It is generally supposed that the r
rises about fifty minutes later every day
on the preceding; but this idea is co
only with respect to those parts abou
equator; for in places of considerable lati
as in England, there is a remarkable d
ence about the time of harvest, when
several evenings successively, the full-m
rises very soon after sun-set; and by
appearing before the termination of twili
she prolongs the light to the great bene
the husbandman, who is employed in gat
ing in the fruits of his labour; and hence
full moon at this season of the year is a
denominated the harvest moon.

The people who reside at the equato
not receive this benefit, nor, indeed, do
stand in need of it, their seasons varying
little, and their weather changing at per
cal times.—At the polar circles, where
mild season is of short duration, the aut
nal moon rises at sun-set from the first to
third quarter; and at the poles which

cides with the ecliptic. In northern latitudes, the *least* angle made by the horizon and ecliptic is, when Aries rises and Libra sets: as the *greatest* is made when Libra rises and Aries sets. In the latitude of London, as much of the ecliptic rises about Aries and Pisces in two hours, as the moon goes through in six days; and, of course, while the moon is in these signs, she differs but two hours in rising for six days together; that is about twenty minutes later, at a mean rate, every day or night than on the preceding. In about a fortnight afterwards, however, the moon comes to the opposite signs Libra and Virgo, and differs almost four times as much in rising, appearing about an hour and a quarter later every day or night than on that which preceded it.

As the moon can never be full but when opposite to the sun, and that luminary never appears in Virgo and Libra but in August and September, the moon is never full in the opposite signs, Pisces and Aries, but in those months; and hence it is sufficiently obvious that we can have but two full moons in the year, which rise so early for a week together, as already mentioned.—The former of these is called the *harvest* moon, for the reason previously assigned, and the other is called the *hunter's* moon.

The moon being in Pisces and Aries every lunation, must consequently rise in this manner *twelve times* in the year; but in winte

she rises in these constellation
she is waxing; in winter at
she is waning; and in spring,
at the time of her change.
former instances, she is but a
at the time of change is invi
tion that there are but two
above description in a year i
affected by these circumstance

As the ecliptic and horizo
every day, for an instant, on
one half of the ecliptic, fro
point to another, rises, and
sets at the same moment; tha
once is twenty-four hours in s
which sets at once is twent
rising.—At the poles, one hal
is continually above the horiz
half never rises. It is, also,
serve, that the augmentation
our moon-light depends upon
our satellite to the sun. Her
parts of our globe where the
and tedious, receive the greate
light from the moon, and i
antarctic regions it shines ev
night, or from the first to th
without setting.

duced upon all occasions, to
of unfeigned praise and ado-
OD who at first created, and
at great system of the uni-

HAPTER VIII.

lipses of the Sun and Moon.

e phenomena of the celestial
are none more worthy of atten-
lar and lunar eclipses; and to
e unacquainted with the princi-
nomy, nothing appears more ex-
than the precision with which
ences are calculated and predicted.
y ages of the world, appearances
ure were considered as alarming
, or sure indications of the displea-
eaven, insomuch that hostile armies
known to lay down their arms and
ite their quarrel amicably, on per-
e bright luminary of day overspread
kness; and even the philosophers
es, with very few exceptions, were
t a loss to account for what appeared
as a deviation from the established
nature.

rocess of time, however, when the
f science began to irradiate the minds

of mankind, and the motions
bodies were more clearly un
phenomena, formerly considere
portentous, were found to be
regular cause, and to admit of
natural and easy.

To enter into a minute exp
the principles of this doctrine
sistent with the plan of our w
probably fatigue rather than int
of our young readers. We
merely endeavour to give a pla
idea of the subject, and to ex
any embarrassing calculations
astronomical figures, the fou
which it rests.

Eclipses may be said to de
very simple principle. that all
bodies when exposed to the lig
cast a shadow behind them in
rection; and as the earth is
kind. whose shadow extends ov
and to a considerable distance,
that the moon in passing thro
must of course be eclipsed, or
light.

un is larger than the earth. This
case, and the form of our globe being
, the shadow it casts must be conical,
inate in a point at a certain distance
sun, falling upon that point directly
: to his place in the ecliptic.
shadow of the moon is, also, of a conic-
re, and when it falls upon any particu-
tion of our earth, that part will natu-
e involved in darkness, and the sun, to
abitants of such part, will seem eclipsed
the shadow continues to cover them:
s the moon is considerably smaller than
arth, and its shadow can cover but a
portion of the earth's surface, there will
total deprivation of light only in that
: where the shadow falls; while the in-
ants of the circumjacent places will per-
the sun's disk to be obscured in a greater
ss degree according to the contiguity or
teness of their situation Hence it ap-
, that solar eclipses are always confined
rticular places: but lunar ones may be
ved from every part of the earth, provi-
he moon be above the horizon at the time
r obscuration.
pposing the sun and moon to be of the
size, the moon's shadow would frequently
· a portion of the earth's surface of more
two thousand miles in breadth: this
ver, is contrary to the fact, for, except
tal eclipses of the sun when the shadow
very obliquely, it rarely extends above a

hundred and fifty miles in breadth; whi
plainly demonstrates that the magnitude
the moon is much less than that of the
And as it is known from the duration of m
lunar eclipses, that the earth's shadow i
pable of covering a body three times l
in diameter than the moon, it is obviou
the moon is considerably less than our

From what has been premised, our readers will easily perceive that there no eclipse of the moon but when she i full, or in opposition to the sun; and eclipse of the sun can only occur at moon, or when it is in conjunction luminary: for at those times alone and the moon are in a direct line sun.

Now as there is a new and full m month, it may be conjectured by enquirer, that there should be a so at those periods; but briefly as I

pressed below it, it is impossible
n should ever be in the same plane
rth, except when she is in the
one of the points where the or-
t each other. Hence it is obvious,
moon may perform many revolu-
the earth, before a new or full
place in one of these points,) there
clipse either solar or lunar in the
eral months
moon's nodes, or points of inter-
in a right line with the centre of
new or full moon, the sun, moon,
re all in a right line; and if the
n new, her shadow falls upon the
ll, the earth's shadow falls upon
hen the sun and moon are more
een degrees from either of the
time of conjunction, the moon is
ther too high or too low in her
part of her shadow to fall upon
And when the sun is more than
ees from either of the nodes at the
sition, the moon is generally too
low in her orbit to pass through
the earth's shadow; whence it
no eclipse will happen in either
s.

moon be less than seventeen de-
either of the nodes at the time of
, her shadow will fall upon the
portion as she is more or less with-
; and if she be less than twelve

moon's orbit contains 360 degre
17, the limit of solar eclipses on
the nodes, and 12 the limit of l
are but small portions) it is obvic
must be many new and full mo
any eclipse

Having already had occasion
the *nodes* of the moon, it may be
this place to explain the term t
readers.—The moon's orbit in
ecliptic in two points diametric
to each other, and these inte
called the nodes. The *ascending*
the dragon's head, is the northern
of the moon's orbit with the ecl
marked thus by astronomers ☊,
ing node, or dragon's tail, is the
tersection, and is marked thus, ☋

Supposing the line of the nod
ways carried parallel to itself ro
there would be exactly half a y
the conjunctions of the sun and
as the nodes shift toward the w
trary to the annual motion of the
nineteen degrees and one third i
same node will come round to t
nineteen days sooner every year
preceding one: hence, from t

g node passing by the sun, as seen
› earth, there will be only 173 days
.e descending node passes that lumi-
whatever time of the year, therefore,
eclipses about either of the nodes, we
ect to have eclipses about the other
› hundred and seventy-three days af-

›des shifting through all the signs and
of the ecliptic in 18 years, 225 days,
uld always be a regular period of
if any complete number of lunations
shed without a fraction.—This, how-
'er occurs; but in 223 mean luna-
about 18 years and 10 days after the
n, and nodes, have been once in a
›njunction, they return so nearly to
state again that the same node which
›njunction with the sun and moon at
nencement of the first of these luna-
l be within less than half a degree of
conjunction with the sun and moon
hen the last of these lunations is com-
In that time, therefore there will be
· period of eclipses, or returns of the
pses, for many centuries. The fall-
, however, of the line of conjunction
n and moon, with regard to the line
des, in every period, will eventually
t: and after that it will not return
less than twelve thousand four hun-
ninety-two years.

Those eclipses of the sun which hap
bout the ascending node, and begin to c
n at the north pole of the earth, will p
ittle southerly at each return, till they
quite off the earth at the opposite pole;
those which happen about the descending no
and begin to come in at the south pole of
earth, will go a little northerly at each ret
till at last they quite leave the earth at
north pole.

Every variety of eclipse that can possi
occur, either with respect to the sun or mo
is owing to the elliptical figure of their orb
and the position they are in when the ecl
happens.

When the moon changes at her leas
tance from the earth, and is within the p
limits of the node, she will appear large e
to cover the whole disk of the sun: and
inhabitants of our globe where her s
falls will have the sun entirely hid
their view for some minutes. Bu
the moon changes at a greater distan
the earth, and is sufficiently near to th
will subtend a less an
ently, her

est, exceeds that of the sun when
nly one minute and a half a degree
atest solar eclipse that can possibly
ie total darkness will continue no
n while the moon passes through a
d a half of her orbit from the sun;
describes in about three minutes of
t when the change happens within
degrees of the node and the moon
iean distance, the point of her sha-
ust reach the earth, and on the small
: it falls the darkness can be only mo-

l eclipse of the sun may be justly
as one of the most curious and most
ectacles in nature: for at this time
ess is intense, the stars appear, and
creation, as well as superstitious or
bservers, seem struck with terror;
ation, in general, is but for an in-
, at the utmost, continues little more
minutes of time.—It may, also, be
that such eclipses occur but seldom
ticular place, and annular ones are
uncommon.

eclipses of the moon, that planet is
risible, but generally appears of a
, like the colour of tarnished copper.
pearance has been thought to result
noon's native light; but it should
eferred to the scattered beams of the
are so bent into the earth's shadow,
hrough the atmosphere, as to afford

ipses in which the moon
her orbit nearest the earth,) has ...
peared; but such instances are rarely hea
. Hevelius mentions one eclipse of th
nd. which happened on the 25th of Apri
642, when it was impossible to discover th
place of the moon, even with the assistanc
of a telescope, although the sky was sufficien
ly clear to discover stars of the fifth magn
tude.

Our readers will easily perceive from wh
has been said, that a total eclipse of the mo
may occur, although she be not exactly
either of the nodes at the time of such eclip
for as the diameter of the earth's shado
considerably larger than that of the m
she may, of course, be wholly involved i
dark cone, without passing directly thr
... moon, also, may be at

cording to the number of those parts are obscured. It is also necessary to rk, that an eclipse of the sun always be- on his western side and goes off on his tern; and that an eclipse of the moon be- on her eastern side, and goes off on her stern. And all that the moon is eclipsed above twelve digits, marks how far the earth's shadow extends over her body, on that edge to which she is nearest at the middle of the eclipse.

Solar eclipses are more frequent than lunar ones, because the sun's ecliptic limits are greater. There are, however, more *visible* eclipses of the moon than of the sun, because these are seen from all parts of the earth where the moon is above the horizon at the time the eclipse happens, whilst those of the sun can only be observed on that small portion of the hemisphere in which the moon's shadow falls.

The greatest number of eclipses of both luminaries which can happen in one year is seven, and the least two; but the most usual number is four; and there are scarcely ever more than six, of which one half are generally invisible at any particular place.

From a due consideration of these particulars, the young reader will comprehend the doctrine of eclipses, and will perceive that it is no difficult matter for astronomers to pr dict the exact time when any phenomenon this kind will make its appearance. F

an eclipse can only happen at the
or full moon, the principal requisi
certain the number of mean con
oppositions that will occur eve
the exact situations of the sun
their orbits at each of these time
then appear, that the two lumina
in the proper limits of the node,
an eclipse, or otherwise not, agre
previous observations.

It is extremely difficult, even
telescope, to observe exactly ei
mencement or ending of a luna
the earth's shadow is so faint an
defined about the edges, that wh
is either just touching or leaving
ration of her limb is scarcely sensi
sequently the most attentive
hardly deem himself certain w
seconds. The beginning and en
eclipses, however, are visibly in
for at the moment that the edge
disk touches that of the sun, l
seems rather broken on that p
instant she leaves it, she appears m

etween them: in *geography* the lon-
any particular place may be found
es, as we have explained in a former
and in *chronology* both solar and lu-
ses serve to fix the precise time of
event; for so many particulars are
le in every eclipse (especially of the
h respect to its quantity, the places
is visible, and the time of the day
that there cannot be two solar eclipses
n all circumstances in the course of
es.

CHAPTER IX.

Phenomena of the Tides, Winds, &c.

a known fact that more than half the
f the earth is covered with water, and
e fluid body appears in continual mo-
ing and flowing alternately without
rmission. It is also worthy of obser-
hat these motions invariably follow
ain rule; for if the tide at a given
at high-water mark in any port or
lying open to the ocean, it will soon
sink, and flow regularly back till it
l at low water-mark, which will be in
t hours. After this it will gradually

rise to
time ebbing
space of twenty-four
The interval between the
of the tide, however, is not exactly
but about eleven minutes more, so that
time of high water happens about forty-
minutes later every day for thirty days;
which it recurs as before. Thus if it be
water to-day at noon, it will be low wa
eleven minutes past six in the evening
after two more changes, the high wate
day will happen about three quarter
hour past twelve; the day following
occur at half an hour past one, and
thirty days, when it will be high
noon, as on the day when the obser
first made. This corresponds ex
the motion of the moon; for she
forty-five minutes later
and by moving in
her

must be comparatively small on account his immense distance from the earth.

The attractive force of the moon acts unequally upon different parts of the ocean, and consequently causes it to assume a different figure from what it would otherwise have. And as this attractive force is most powerful on that part of the ocean immediately under the moon, the waters will, therefore, flow constantly to that part, and be higher or lower at different places according as her situation varies with respect to those places. But as the earth turns on its axis, in about twenty-four hours and three quarters, from the moon to the moon again the flux and the reflux will, of course, be retarded from day to day about forty-five minutes.

Hence it is sufficiently obvious that the tides are occasioned by the attractive force of the moon; but we have yet to explain the more singular circumstance of their ebbing and flowing twice every twenty-four hours.

When the moon passes the meridian, or is at her greatest height above the horizon of any place, she will naturally attract and elevate the waters lying immediately under her; but it may be asked why the waters are elevated at the same place twelve hours afterward, when the moon passes the meridian below the horizon? for it is a known fact, that whether she be in the zenith or nadir the phenomenon is nearly the same, it being high wa-

ter with our antipodes at t
it is high water with us.

At any port or harbour
ocean, the moon's attracti
elevate the waters when sh
of that place, whether it
the horizon. The water, h
elevated at one place witho
at another, whence it has b
is sufficiently evident that t
depressions must be most
posite points of the earth
the moon raises the wate
points, they will, of cours
the other: and as the mo
meridian and is in the ho
day, there must consequent
two flood tides in that time,
six hours and eleven minute

From a cursory perusal
marks, our young readers
that the time of high water
place would be when the
meridian of that place

meridian, yet from the motion previously
municated to the waters, they would con-
ue to ascend for some time afterwards con-
sently they must be still more disposed to
nd when the attractive force has suffered
y a small diminution. These effects, like
continuation of the waves of the sea after
orm has subsided, and the increase of heat
or three hours after noon on the longest
, may be easily understood, from the con-
ration that a small impulse given to a
y in motion will cause it to move further
a it would have done without such impulse.
tead of its being high water, therefore,
n the moon is upon the meridian of any
e, it will be found to happen about three
rs afterward.

t is necessary to observe that tides might
roduced by the influence of the sun, though,
ve have already observed, in a much less
ree. The whole attractive force of the
indeed, is greatly superior to that of the
n, but as the distance from our globe is
rly four hundred times greater, the forces
h which he acts upon different parts of it
much more equal than those of the moon,
, of course, have less effect in occasioning
mutation of its figure.

n illustration of this doctrine it may be
erved, that notwithstanding the considera-
proportion which the earth's diameter
rs to its distance from the moon, yet this
meter is scarcely any thing in comparison

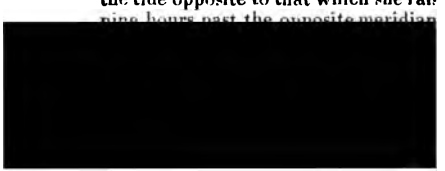
with the earth's distance from ...
difference, therefore, of the sun's att...
those sides of the earth which lie under ...
opposite to him, will be considerably less tha...
the difference of the moon's attraction on t...
sides of the earth which are under and op...
site to her; consequently the moon must ...
vate the tides much higher than they c...
raised by the sun. And as the great fi...
Newton discovered the effect of the s...
fluence in this case to be three times ...
that of the moon, it is evident that ...
the sun alone might occasion an el...
flowing of the sea, the elevation ...
sion thus produced would be thre...
than those occasioned by the moo...
these considerations it m...
the tides are pr...
sun and m...

: tides happens when the sun and
ecisely in the situations alluded to:
r actions do not produce the great-
ien they are the strongest, but some
ards, as we have previously intr-

lso, be observed. that the agitating
e sun and moon depend not only
particular situations, but, also,
espective distances from the earth:
ects will be greater in proportion
ıtiguity; whence it happens that
tides are greatest in winter, when
rthest off, and the neap tides are
y least. For a similar reason, as
avels round our globe in an ellip-
d is nearer at some times than at
ides, at such times are invariably
augmented or depressed.
iations are, likewise, produced by
declinations of the two great lu-
or if either the sun or moon were
e poles, it would occasion a con-
oth there and at the opposite pole,
ınt ebb, or depression about the
proportion, therefore, as these lu-
cline from the equator, they grad-
ıeir effect, and the tides are dimin-
when both of them are in the equa-
:s are consequently augmented.
eas the elevation of the tides is
iderable, in comparison of that
served in wide-mouthed rivers

opening in the direction of the stream for in channels which gradually beco rower, the water is accumulated by position of the contracting banks; in manner as a gentle wind, though scar on an extensive plain, seems brisk in particularly if the widest end of th open to the plain, and in the directio wind.

Tides in respect of different places at all distances of the moon from the owing to their being obstructed in t sage through different shoals and and being also variously affected by against capes. headlands, &c. consequer occur at all hours of the day. The h produced in the German ocean when is three hours past the meridian, take hours to flow from thence to Londo where it arrives by the time that a r is raised in the ocean. At many pla it is high water three hours before t comes to the meridian; but that tid the moon seems to push before her i the tide opposite to that which she rai



nunicating with the ocean being
that they cannot, in so short a
ve or discharge sufficient water to
sensible swell or subsiding of their

the atmosphere of our earth, being
lighter than water, it cannot be
at the moon produces much higher
ie air than in the ocean; and the
ie moon's attraction upon our at-
is known to be one cause of the
; that prevail about the time of the
though the principal cause must be
) the change of temperature which
)here then undergoes. It remains
, as briefly as possible the nature of
n at different times, and in various

he action of the sun, the attraction
n, or any other cause, dilates the
region of the atmosphere, it must,
ence of its expansion, force itself
er region, which, if less rare, will
y produce a wind. Heat may be
as the chief cause of the air's dilata-
equently when the reflection of the
rom the earth has heated the air to
legree, it becomes lighter in those
in the adjacent ones, which occa-
lenser air to rush into it, to restore
rium
ıting of the denser air into the
ices the agitation called wind; and

air [illegible]
equilibrium,
perature through[illegible]
time that they moderate [illegible]
ern regions by a stream of [illegible]
which are colder, and meliorate the
the northern regions by the warm a
south.

The former of these effects is mos
experienced by those who inhabi
pics, where the solar beams fall
mulated ardor, and cause the a
tremely heated during the sun's
the waters surrounding the
these effects are less powerf
their absorbing a greater p
rays, when he sinks below

...e air regains its proper equilibrium; ... it has been justly remarked, "the ... air of the ocean rushing into the heated ... refreshes and purifies it by its coolness and wholesome nitrous impregnation."

There are some parts of the torrid zone where an easterly wind prevails during the whole year, and, by its constancy affords such important advantages to merchants, and navigators in general, that it has been aptly termed the *trade wind*.

Various conjectures have been formed respecting the cause of this phenomenon; but the following mode of accounting for its regular action seems the most rational in itself, and best adapted to the plan of a work designed for the instruction of juvenile readers.

Those parts of the earth situated between the tropics are more heated than any other regions, in consequence of their receiving the greatest portion of the solar rays, and their atmosphere being considerably dilated by that circumstance. On the sun's departure, therefore, from any particular spot, the cooler air will naturally rush in, to restore the equilibrium; and this may produce the constancy of the wind under consideration.

To account for its direction we observe, that as the earth's diurnal motion is from west *to east*, and the apparent motion of the heavenly bodies is in an opposite direction, the ... *may be* said to pass westerly. Now that ... *of the* atmosphere subjected to the sun's ...

ence, being most heated on his retreating thence in a westerly direction, the cold air rushes in behind, and occasions a constant current of wind from the east.

It is proper to remark, that the cold air west of the sun's place cannot rush into the heated air, on account of the approach of that luminary. The cool air on the north and south however, is not thus impeded, and therefore, if the sun be on either side the equator, the cross wind from that quarter combining with the easterly current, causes it to be either north-east or south-east; but the force of each is only in proportion to its stream d direction. When the sun is on the north si of the equator the wind blows north-ea and when he is on the southern side, it blo south-east.

Our readers must be informed, howe that the easterly current of air, which have been describing, is not constant ex on the open sea; for in the vicinity of isl &c. the heat reflected from their su tends to counteract the cause of the winds; and from the change which the this circum-tance, marine land winds.

CHAPTER X.

Motion, Refraction, and Aberration of Light.

NY and various opinions have been concerning the nature of light—a sually inportant in itself and interesting y lover of science.—The Greeks appear e considered it as an accident, or pro- resulting from the first principles of ; and Des Cartes has defined it to be a ous matter diffused through the creation, by the action of the sun, strikes upon es, in the same manner as a rod, or staff, if pushed at one extremity enters in the ioment at the other.

now well known that light is a mate- stance, which flows directly from the its proper fountain ; and the velocity hich it moves may likewise be ascer- with tolerable precision.—The Danish pher, Roemer, first demonstrated that loys about eight minutes in travelling e sun to our globe a distance of nine- millions of miles ; and as this curious e may naturally be expected to inter- young reader, we shall endeavour to *it* as clearly as possible ; having pre- remarked, that an attentive observa- *the* eclipses of Jupiter's satellites fir e *important* discovery.

lites is eclipsed about ... when the earth is nearest to Jupiter than when it is most remote. And this must be occasioned by the time which light takes in passing through the diameter of the earth's orbit; for we are well convinced that these accelerations cannot result from any inequalities in the motions of the satellites themselves, because, whatever parts of their orbits the eclipse happen, they are invariably affected in the same manner.

When a ray of light passes out of one medium into another of different density, it is said to be refracted, or broken in its course in proportion as it falls more or less obliquely on the refracting surface which divides the two mediums. And this proposition may be illustrated by a very simple experiment ... basin

bottom of the vessel.—The rays of
st consequently be refracted, or bent
d in passing out of the water into
and as they now come to the eye in
blique direction, the object must, of
pear elevated, and in a different po-
m its real one.

ypothesis may also be illustrated
lace the basin in such a manner that
ay shine on it obliquely, and observe
rly where the shadow of the sun
the bottom: then fill it with water,
hadow will not extend so far as it
the basin was empty, which plainly
hat the rays have been refracted,
out of their natural course, by pass-
one medium into another of a different

re may observe that in proportion
s fall less obliquely, the less will be
action, and if they fall perpendicu-
y will not be refracted at all: for the
riment demonstrates that the higher
ises, the less difference will there be
the places where the edge of the
alls in the empty and full vessel;
suppose a stick to be laid across the
l the solar rays to be reflected into
dicularly from a mirror, the shadow
ick would fall upon the same part of
whether it were full or empty.

sequence of this property of refrac-
enjoy the light of the sun, even

mornings, [illegible]
really ascends above the [illegible]
the same cause, the sun and the full moon,
when on the horizon, do not appear perfectly
circular, their vertical diameters seeming less
than the horizontal one. They also appear
larger at such times than when they are more
elevated, but this must be considered as an op-
tical delusion.

When these luminaries are on the horizon,
they seem to be more remote than at other
times, and if seen under the same angle or of
the same real magnitude, we naturally imagine
them larger. Thus a large ball on a very high
spire has but a minute appearance, in compa
rison of what it would have if lying on th
ground at the same distance from a spect
In the former instance, its distance a
In the latter we
less than

he all-wise Creator
m atmosphere, the
come to us in direct
nd disappearance of
instantaneous; cor
experienced the m
ransitions from pro
f light, and from
cheerless and oppre
, the effect of refra
for the coming sple
vening we behold
on the western clou
f the receding lum
vening gradually d
landscape, and ha
ation, when the m
ess majesty, and t
pears studded wit
eir surrounding

stronomers seem to
h the refractory pc
ut its effect does no
lined nor employed
observations, til
e. He discovered
be about thirty-
ch the same as it i
onomers: he, also,
for ascertaining it
itudes, but this ph
ndeavours. He e

success to the gross vapours wh
atmosphere, and supposed th
the sun to be different from th
His mistake, however, was aft
ered by Dominique Cassini,
the refractions for every deg
and proved that they diminish
zon to the zenith.

As the state of the atmosph
variable, and the quantity of
always the same at the same
can be laid down for ascertain
sion, either the height of that
mosphere which refracts the su
true place of any of the heaven
are seen through this medium.

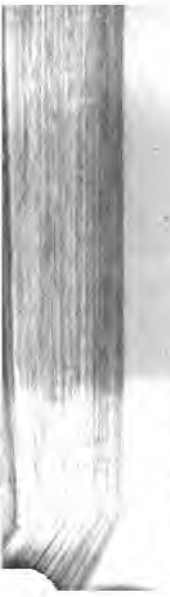
It is not, however, from
that we are unable to fix the
these objects, but they are also
gularities occasioned by the
light; the discovery of which
oned among the most remarka
of the eighteenth century. A
ject is equally curious and imp
present our readers with it, a
Encyclopædia Britannica, un

rallax of the earth's annual orbit. And after repeated observations, they found this star, about the beginning of March, 1726, to be twenty seconds more southerly than at the time of the first observation. It now, indeed, seemed to have arrived at its utmost limit southward: because in several trials made about this time, no sensible difference was observed in its situation.

"By the middle of April it appeared to be returning back again towards the north; and about the beginning of June, it passed at the same distance from the zenith as it had done in December, when it was first observed. In September following, it appeared thirty-nine seconds more northerly than it was in March, just the contrary way to what it ought to appear by the annual parallax of the stars. This unexpected phenomenon perplexed the observers very much, and Mr. Molyneux died before the true cause of it was discovered.

"After this, Dr. Bradley, with another instrument more accurately adapted to his purpose, observed the same appearances, not only in that, but many other stars; and by the great regularity that appeared in a series of observations made at all times of the year, the Doctor was fully satisfied with regard to the *general laws* of the phenomena; and therefore endeavoured to find out the cause of them.

"*He was* already convinced that the ap*rent motion of* the stars was not owing to *nutation of* the earth's axis. The next



last, however, this acute ast
the phenomenon in questio
the progressive motion of lig
annual motion in its orbit:
that if the light were propa
apparent place of a fixed ob
the same when the eye is at
moving in any other direc
the line passing through th
and that when the eye is m
directions, the apparent pl
would be different."

From various observatio
Bradley upon the same stars
three years, he discovered a
twenty seconds between the
rent places: and hence, the
appears to be ten thousand t
that of the earth in her orb
light will travel from the su
eight minutes and about seve

This discovery of the aber
an incontrovertible proof of
tion in her orbit, and affords
confirmation of the correct
solar or Copernican system;
has clearly ascertained th

[redacted] combined with the motion of our globe, occasions an apparent difference in the situation of the fixed stars; and as this motion evidently affects all the stars in a different manner, according to their places in the heavens, such a similarity of variations affords indisputable proof that the system of the universe as revived by Copernicus and improved by the immortal Newton, is strictly conformable with the true order of nature.

CHAPTER XI.

Of the Golden Number, Epact, Cycle of the Sun, Dominical Letter, &c. with easy methods of ascertaining them.

THE *prime*, or *golden number*, is, in other words, the cycle of the moon, or a circle or period of nineteen years, at the expiration of which, the changes of the moon will happen upon the same day (but upwards of an hour sooner) and she will make the same aspect with the sun as she did nineteen years before. It is said to have derived its appellation of *Golden* number from Julius Cæsar, who caused it to be inserted in the calendar in letters of gold. It is of great utility in ascertaining the age and changes of the moon; and may be easily found by any of our readers who are *tolerably* acquainted with common arithmetic.

solar exceeds the lunar year; t
vulgarly reckoned three hundre
and the lunar, three hundred
days, the difference, viz. eleven
the epact. Thus the epact of on
days; two years, twenty-two d
but as thirty are accounted a
tion, the pupil must subtract
ceeds that number, and the re
the epact.

As a general rule for finding
1 from the golden number, and
mainder by 3, when, if nothin
epact will be the same as the
less than the golden number:
add 10 to the dividend, or if 2,
sum will be the epact, for th
new style.

ist quotient, and rejecting the number 30
en as you can, the remainder will be the
.

e *Cycle of the Sun* is a revolution of
ty-eight years, at the expiration of which,
ominical, or Sunday letters, return again
e same order they were in twenty-eight
before, and the twenty-ninth year be-
a new cycle.

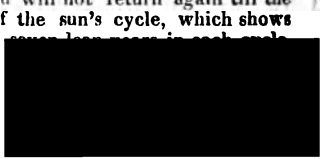
find the cycle of the sun in the present
ry, add 25 to the date of the year, then
e by 28, and the remainder will give the
cycle for that year. After the year
, however, the rule will be as follows:
ie number added in the nineteenth centu-
ie. 25) the pupil must add 16 more, and
that sum subtract 28, and the remainder
ie the number, to be added to the date of
ear from 1900 to 2000.

e *Dominical Letter* is so called because
he lordly letter, or that which is placed in
calendar, against the first day of the week,
nday. There are seven Dominical letters
ering to the days of the week, viz. A, B,
, E, F, and G: and these letters are also
for every month of the year, A being set
nuary first, B for the second, C for the
, &c. till they come to G, and then they
ience again with A.

account for the variation of these letters
year, we observe, that as the common
nted year consists of three hundred and
five days, and as seven days make a week,

hat if 365 be divided by 7, the
be 52 weeks and 1 day over: this
equently be the last of Decem-
ould be letter A, but we have
narked that this is used for Jan-

he year to consist only of three
sixty-four days, there would be
er of fifty two weeks: in which
ears would begin on the same
ek, but being three hundred and
s, the year ends with the same
with. Thus in any common
ing the first day of January to
unday, the next year will com-
Monday, and Sunday will be the
f January or letter G; and as the
ar will begin on Tuesday, and
appen on the sixth day, the Do-
then will be F, &c.
th year, however, is called a
Leap-year, and consists of three
sixty-six days, and therefore
the Dominical letter will be in-
d will not return again till the
f the sun's cycle, which shows



y, will have the letter G, so that every
ear has two Dominical letters, one,
serves from the first of January to the
y-fourth of February, and the other
he twenty-fifth of February to the end
year.

general rule for finding the Dominical
is as follows:—Add to the given year
rth part omitting fractions; then divide
m by 7, and the remainder subtracted
will represent the number of the letter
ling to the order of the alphabet; thus
signify A, 2 B, &c. But if nothing re-
fter dividing by 7, then G is the Domin-
tter.

letter found according to this rule will
e Dominical letter from the twenty-
of February to the thirty-first of De-
r; and the other letter from the first of
ry to the twenty-fourth of February,
e always the next in the order of the
et.

find the Dominical letter after the com-
ment of the nineteenth century, the
must attend to the following rule:
sing the Dominical letter for 1845 to
uired—Cut off two figures thus 18 | 45,
the first two, viz. 18, by 4, regarding
nainder: the quotient will be 4, from
subtract 1, and the remainder will be
ch taken from the original number will
15; this number subtracted from 21,
umber of seven nearest eighteen) leaves

Of the General Principles of a
with Problems, &

THE artificial celestial glob
represent the face of the hea
all the fixed stars hitherto per
nomers are placed in their r
and respective magnitudes;
globe is turned round on its
west, it exhibits the *apparent*
of the sun, moon, and stars,
regions.

There are two circles on th
intersect each other; one ca
represents the sun's apparen
other the *equator*, or the circ
which in celestial problem
transferred in idea to the hea
ner is distinguished by eigh
parallel to it on each side,
twelve signs of the zodiac, div
degrees each, and forming

ircle of three hundred and sixty degrees.
utter, when transferred to the heavens,
ed the *equatorial circle*, because it only
to divide the celestial sphere into two
parts, being precisely equidistant from
extremity of its apparent diurnal mo-

23½ degrees from the equatorial circle
arallel with it, two circles are drawn,
n the north and the other on the south
which touch the ecliptic in two points.
circles are called the *tropics* or *solstices*;
ne great circle which passes through the
where the tropics touch the ecliptic, is
the *solsticial colure*. Another great
which passes in like manner, where the
ic and equatorial intersect each other, is
d the *equinoctial colure*; and the circles
n at 23½ degrees from the poles are called
olar circles.

the plane of the horizon of the celestial
, are delineated the figures and signs of
odiac; the degrees of which answer to
ays of the months, as the months corres-
to the signs which the sun is in at each
l. On this place also are described the
ipal and collateral points of the compass.
e brazen circle which crosses the globe
and south is styled the *general meridian*,
its representing that circle which passes
every place on the earth.
e altitude of any heavenly body is its
t above the horizon.

Meridian Altitude is its greatest hei
when it arrives at that height, it i
culminate.

Declination, is the distance of the
any star, from the equator or equ
counted on the brazen meridian in
and is called north or south, accordin
side of the equinoctial on which the
tion is.

Right Ascension, is an arch of the
tial contained between the sign Ar
the degree of the equinoctial that i
the brazen meridian, when the sun o
brought to the meridian.

Oblique Ascension, is that arch of t
noctial contained between the sign A
the degree of the equinoctial, which
the horizon at the rising of the sun or

Ascensional Difference, is the diffe
degrees between the right and obliqu
sion, which converted into time by
15 degrees for every hour, shows ho
the sun, or star, rises or sets before
six o'clock.

Latitude of a Star, is its distance
ecliptic, being an arch of a circle of lo

Sun's place in the ecliptic, is called its
de; but it is usually expressed by the
and minute of the sign in which it is.
levation of the pole above the horizon,
me as latitude on the terrestial globe.
ude and Longitude, therefore, on the
l globe bear the same relation to the
, as they do on the terrestrial globe to
ator.

e are the general principles of a celes-
e, which being well understood, will
the method of working problems on it
intelligible and easy.

PROBLEM I.

ctify the Globe for any given Latitude.

uld rectify the globe for latitude 40
north.

s.—Turn the pole on which the hour
fixed towards the north point of the
, slipping or moving the whole globe
rds or forwards in the notches of the
, till the horizon cuts the brazen me-
1 40 degrees, so the globe will be rec-
latitude 40 north.

were required to rectify the globe for
ıtitude, then you must elevate the
le instead of the north pole.

RULE.—
horizon of the globe, and
and degree of the sign, that the sun is
that day.

I would know the sun's place in the ecl
on May the 21st, March the 21st, Jun
21st, and December the 21st. I loo
these days of the month in order as they
in the calendar, and against the day
month, in the innermost circle of the
I find the sun's place among the signs.

Thus against May the 21st, I find
of Gemini, and also on March the 21s
the sun enters Aries, on June the
enters Cancer, and on December the
enters Capricorn.

PROBLEM III.

*The latitude and day of the month be
to find the sun's place in the ecliptic
the globe for use.*

RULE.—Find the sun's place on
as before directed, and having not
gree he is in, look upon the ecli
globe and find the same sign an
you did on the horizon, then brin
of the ecliptic very carefully to
edge of the brazen meridia

steady, turn the index exactly to the r twelve, which represents twelve at noon, thus is the globe rectified for that day, the degree of the ecliptic that lies under meridian represents the sun's place at noon, twelve o'clock that day.

PROBLEM IV.

he latitude and day of the month being given, (suppose January the 1st, at 9 o'clock at night, at Philadelphia) to set the globe so as to represent the face of the heavens at that time, and show the names and position of the most eminent fixed stars.

RULE.—Rectify the globe for the latitude, and bring the sun's place to the meridian, and the index to 12; then turn the globe to the given hour, viz. 9 at night, and there fix it. So will every star on the globe, if you set the globe north and south, correspond with, or point to the same star in the heavens; and then observing some star which you know as the Pleides (commonly called the seven stars) in Taurus or Aldebaran, find the same on the globe, and take notice of the position of the contiguous stars in the same or an adjoining constellation; direct your sight to the heavens, and you will see those stars in the same situations. Thus you may proceed from one constellation to another, until you have learned the most of the principal stars.

Rectify the globe, and bring the ... place to the meridian: then turn the g till the given star come to the eastern v of the horizon; and the index will show time of rising, and the horizon will disc the point it rises upon. Turn the glob the west, and the index will point to the of setting, and the horizon will show the it sets upon.

PROBLEM VI.

To find those stars which never rise, and which never set, at London.

Observe what stars have more than 38 grees south declination, for those never but are always under the horizon at Lon in like manner, those stars that have ... south declination, never

n side of the horizon for the
ll those stars cut by the e
; horizon *rise* cosmically.
the same position, and lo
verge of the horizon; th
cut by it or lying very n
ay cosmically. Turn the gl
edge of the horizon, and ol
of the ecliptic cut by the e
same time which will answ
ıe cosmical setting.

PROBLEM VIII.

time of the achronical risin
setting of any star.

ectified your globe for the l
, &c. bring the given star
;e of the horizon, and observ
ecliptic is, at the same ti
verge of it. The latter bei
-setting, by observing the
which the sun is in that si
time of the achronical ri
tar will be found. If you
the western verge of the h
e the point of the ecliptic w
: time, at the eastern verg
ondent day, or that in whi
ıronically, will be found.

Rectify the globe, and bring the given
to the eastern edge of the horizon; then
the globe and turn the quadrant westw
till 12 degrees of it touch the ecliptic
then will the sun's place be depressed 12
grees below the horizon on the eastern
This done, observe the degree of the ec
cut by the quadrant, and find the opposi
gree; and the day of the month against
same degree of the ecliptic on the horizo
show the time of the star's heliacal
The same is to be observed with the qu
on the eastern side for the heliacal setti

PROBLEM X.

To find the sun's meridian altitude for an day.

and when th

ıe quadrant together, till the star cut the ant in the given height; and the index oint to the hour.

: the exercise of the young reader, we given a list of the different constellations; situation on the globe, and the names of inciple stars in each of them.

CONSTELLATIONS.

'a, the Eagle, extends from degree 280 to 5 upon the equator, passes between degree on the northern, and 15 on the southern e of the meridian. Principal stars, Al- r of the first, Varia of the second magni- le.

ga, the Wagoner, situated in the northern nisphere, extends from degree 65 to 110 the equator; passes between degree 25 d 55 on the meridian. Principal star, Ca- la of the first magnitude.

a Pneumatica, the Air Pump, situated in s southern hemisphere: extends from de- ee 140 to 170 of the equator; passes be- een degree 20 and 45 on the meridian.

romeda, situated in the northern hemis- ere; extends from degree 340 on the stern, to 40 on the eastern side of the ator; passes between degree 20 and

on the meridian.

Apus, the Bird of Paradise, situated
southern hemisphere; extends from
190 to 230 of the equator; passes be
degree 70 and 80 on the meridian.

Bootes, the Drover, situated in the no
hemisphere; extends from degree 200
of the equator; passes between deg
and 55 on the meridian. Principa
Arcturus of the first magnitude.

Camelopardalis, situated in the northe
isphere; extends from degree 40
the equator; passes between deg
90 of the meridian.

Canis Major, the Great Dog, situ
southern hemisphere; extends
90 to 110 of the equator; pa

degree 10 and 40 on the meridian. Principal star Sirius, usually called the dog star of the first magnitude.

Canis Minor, the Lesser Dog, situated in the northern hemisphere; extends from degree 105 to 120 on the equator; passes between 0 and degree 15 on the meridian. Principal star Procyon of the first magnitude.

Cela Sculptoria, situated in the northern hemisphere; extends from degree 60 to 80 on the equator; passes between degree 20 and 50 on the meridian.

Cetus, the Whale, situated principally in the southern hemisphere; extends from degree 360 on the western, to 50 on the eastern side of the equator; passes between degree 15 on the northern and 25 on the southern side of the meridian. Principal stars Menkan of the second, Mira of the third magnitude.

Canes Venatici, the Hounds, situated in the northern hemisphere; extends from degree 180 to 205 of the equator; passes between degree 30 and 55 on the meridian. Principal star Cor Carolis of the third magnitude.

Cassiopeia, situated in the northern hemisphere; extends from degree 340 on the western, to 50 on the eastern side of the equator; passes between degree 45 and 75 on the meridian. Principal star Shedir, of the third magnitude.

Cepheeus, situated in the northern hemisphe extends from degree 300 on the weste

of the meridian.

Corona Borealis, situated in the northe isphere; extends from degree 225 to the equator; passes between 25 and the meridian. Principal star Alph the second magnitude.

Crux, the Cross, situated in the southern phere: extends from degree 175 to the equator; passes between degree 65 of the meridian.

Circinus, the Compass, situated in the so hemisphere; extends from degree 230 of the equator; passes between 55 and 70 on the meridian.

Corvus, the Crow, situated in the southe isphere; extends from degree 180 to the equator; passes between degree 25 on the meridian.

Centaurus, situated on the souther phere; extends from degree 165 the equator; passes between de *65 on the* meridian.

elion, situated in the southern hemis-
ere; extends from degree 115 to 200 on
e equator; passes between degree 70 and
) on the meridian.

;nus, *the Swan*, situated in the northern
emisphere; extends from degree 280 to
330 on the equator; passes between degree
25 and 60 on the meridian. Principal stars
Arided of the first, Albireo of the third
magnitude.

orona Australis, situated in the southern hemisphere; extends from degree 270 to 285 on the equator; passes between degree 35 and 45 on the meridian.

Draco, *the Dragon*, situated in the northern hemisphere; extends from degree 130 to 330 on the equator; passes between degree 45 and 90 on the meridian. Principal star Etinam, of the second magnitude.

Delphinus, *the Dolphin*, situated in the northern hemisphere; extends from degree 300 to 320 of the equator; passes between degree 5 and 20 on the meridian.

Dorado, *the Sword Fish*, situated in the southern hemisphere; extends from degree 60 to 100 of the equator; passes between degree 50 and 70 on the meridian.

Eridanus, *the River*, situated in the southern hemisphere; extends from degree 15 to 80 of the equator; passes between 0 and degree 60 on the meridian. Principal stars Achernan of the first, Formacis of the second magnitude.

the meridian.

Grus, the Crane, situated in the southern
phere: extends from degree 320 to
the equator; passes between degree
55 on the meridian.

Hercules, situated in the northern hemis
extends from degree 235 to 285 of th
tor; passes between degree 5 and 50
meridian. Principal star Ras Alge
the second magnitude.

Hydra, situated principally in the so
hemisphere; extends from degree
140 on the equator; passes between
10 on the northern, and 30 on the so
side of the meridian. Principal st
Hydra, of the second magnitude.

Horologium, the Time-piece, situated
southern hemisphere; extends fro
80 to 65 of the equator; passes be
gree 40 and 70 on the meridian.

tralis, situated in the southern
e; extends from degree 340 on
n, to 70 on the eastern side of the
passes between degree 60 and 90
ridian.
Indian, situated in the southern
e; extends from degree 290 to
e equator; passes between degree
on the meridian.
ed in the northern hemisphere;
om degree 270 to 290 of the equa-
es between degree 30 and 50 on
an. Principal star Lyra, of the
itude.
ted in the northern hemisphere;
om degree 90 to 140 of the equa-
es between degree 35 and 60 on
ian.
Lizard, situated in the northern
e; extends from degree 325 to 340
uator; passes between degree 35
the meridian.
Hare, situated in the southern hem-
extends from degree 70 to 95 of
or; passes between degree 10 and
meridian.
he Little Lion, situated in the north-
sphere; extends from degree 125
the equator; passes between de-
nd 50 on the meridian.
Wolf, situated in the southern hem-
extends from degree 210 to 240 of

southern ...
Musca Australis, situa...
isphere extends from degree ...
the equator; passes between 60 and ...
the meridian.
Mons Mensiformis, situated in the so...
hemisphere; extends from degree 60 ...
of the equator; passes between deg...
and 85 on the meridian.
Musca Borealis, situated in the northe...
isphere; extends from degree 85 ...
the equator, passes between degre...
90 on the meridian.
Norma, situated in the southern he...
extends from degree 230 to 250 o...
tor; passes between degree 50 an...
meridian.
Orion, extends from degree 70 t...
equator; passes between degre...
northern, and 10 on the south...
meridian. Principal stars Bet...
of the first magnitude, Bellat...
other small stars which co...
belt of the second magnitude...
Octans, situated at the pole ...
hemisphere; passes betwe...
90 of the meridian.

horse, situated in the
e; extends from degree
quator; passes between
the meridian. Princi-
Markab, Scherat, Alpe-
nir of the third magni-

tuated in the southern
ls from degree 260 to
passes between degree
ridian.
e northern hemisphere;
20 to 70 on the equa-
degree 30 and 60 on
cipal star Algot of the
nd four stars of the fifth,
ead of Medusa.
ed in the southern hem-
m degree 310 to 345 of
between degree 25 and
Principal star Fomal-
gnitude.
l in the southern hemis-
m degree 120 to 140 of
between degree 15 and

ne southern hemisphere;
ee 350 on the western,
rn side of the equator;
ree 40 and 60 on the me-

situated in the northern
nds from degree 290 to 305

degree 19 on [illegible]
southern side of the [illegible]
star Ros Althagus yed, of the seco
nitude.

Triangulum Australis, situated in the
hemisphere; extends from degre
260 on the equator; passes betwe
60 and 75 on the meridian.

Telescopium, situated in the south
phere; extends from degree 26
the equator; passes between deg
60 on the meridian.

Triangulum Borealis, situated in t
hemisphere; extends from deg
of the equator; passes betwe
and 40 on the meridian.

Toucana, the American Goose, si
southern hemisphere; exte
330 on the western, to 20
side of the equator; passes
50 and 75 of the meridian.

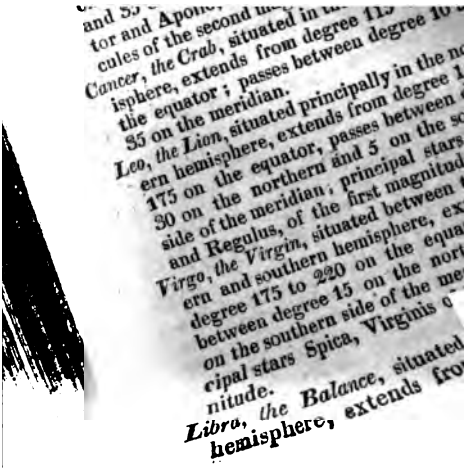
Major, the Great Bear, situated in the ...thern hemisphere; extends from degree ...0 to 220 of the equator; passes between ...legree 30 and 75 of the meridian. Principal stars Dubhe, called the upper pointer, of the first, Alioth Mizar, Benetnaseh, called the lower pointers, of the second magnitude, and Alcor of the fifth.

Ursa Minor, the Little Bear, situated in the northern hemisphere; passes between degree 70 and 90 on the meridian. Principal stars Alruceabah, usually called the Pole Star, of the second, Rochab of the third magnitude.

Vulpecula et Anser, the Fox and the Goose, situated in the northern hemisphere; extends from degree 280 to 320 of the equator; passes between degree 15 and 30 on the meridian.

SIGNS OF THE ZODIAC.

Aries, the Ram, situated in the northern hemisphere extends from degree 20 to 50 on the equator, passes between degree 10 and 30 on the meridian; principal stars, Arietis of *the second*, Mesartim of the fourth magnitude.


and 55
tor and Apoll
cules of the second
Cancer, *the Crab*, situated in
isphere, extends from degree 115
the equator; passes between degree 10
the meridian.
35 on the meridian.
Leo, *the Lion*, situated principally in the n
ern hemisphere, extends from degree 1
175 on the equator, passes between
30 on the northern and 5 on the s
side of the meridian; principal stars
and Regulus, of the first magnitud
Virgo, *the Virgin*, situated between
ern and southern hemisphere, ex
degree 175 to 220 on the equa
between degree 15 on the nort
on the southern side of the me
cipal stars Spica, Virginis
nitude.
Libra, *the Balance*, situated
hemisphere, extends fro

) of the equator; passes between 0 and egree 30 on the meridian; principal stars Zuben el Chama, Zuben el Gemunbi of the second magnitude.

Scorpio, the Scorpion, situated in the southern hemisphere, extends from degree 240 to 265 on the equator; passes between degree 5 and 45 on the meridian; principal star Antares of the first magnitude.

Sagittarius, the Archer, situated in the southern hemisphere, extends from degree 260 to 300 of the equator; passes between degree 10 and 30 on the meridian.

Capricornus, the Goat, situated in the southern hemisphere, extends from degree 300 to 325 of the equator; passes between degree 10 and 30 on the meridian; principal stars Deneb, Algedi of the fourth magnitude.

Aquarius, the Water Bearer, situated principally in the southern hemisphere, extends from degree 300 to 360 of the equator; passes between degree 5 on the northern, and 25 on the southern side of the meridian; principal stars Ancha, and Situla of the fourth magnitude.

Pisces, the Fish, situated principally in the northern hemisphere, extends from degree 340 on the western, to 30 on the eastern side of the equator; passes between degree 30 on the northern, and 10 on the southern side of the meridian.

Aberration—An apparent change of place
the fixed stars, caused by the progress
motion of light, and the earth's annual
tion in her orbit.

Achronical—A term used to express the ri
of a star at sun-set, or its setting at

Al[illegible]*t* of a celestial object
the [illegible]*ion*, or a star, above the
rizon, [illegible]*oned* on a vertical circle fron
horizon to the zenith.

Amplitude—The distance of the sun, or a
from the east point of the horizon at r
and from the west point at setting. A
tude is reckoned east and west.

Aphelion—That part of a planet's orbit w
is farthest from the sun.

Apogee—A [illegible] [illegible] [illegible] from

—The effect which causes bodies to
proach each other.
s—A straight line passing through th
centre of a globe to two opposite point
That line round which any body will r
volve, passing through its centre of gr
vity.
Azimuth—A great circle supposed to p
through the zenith, and perpendicular
horizon.
—A plane figure included within one
ded the circumference, which is e
here equi-distant from the centre
erging—Tending to one poi
rent places.
al—A term denoting
of a star with the sun.
natural or civil—The time in whi
th performs her rotation on her a
artificial or solar—The time the
ve the horizon of any place.
ation—The distance of the su
, from the equator, north and so
e—The 360th part of a circle
ee of the earth's latitude cont
nglish, or 60 geographical mil
quantity of a degree of longitude
ery degree of latitude from th
the poles.
onal—A right line which unit
site angles.
meter—The line which passes fr

of a circle, or other figure, through the centre to the other side.

Disk—The face of the sun or moon.

Divergence—The spreading of light, as it recedes from a centre.

Diurnal—Daily.

Dominical Letter—One of the first seven letters of the alphabet, placed opposite to every Sunday in an almanac.

Ecliptic—The sun's apparent path in the heavens.

Emersion—The re-appearance of the sun, or moon, after it has eclipsed.

Elliptic—Oval.

Epact—The moon's age at the commencement of the year, or the difference between the course of the sun and moon.

Equator—The circle which divides the globe into two equal hemispheres. When the circle is referred to the heavenly bodies it is called the *equinoctial*.

Equinoctial Points—Those two points where the ecliptic and equator intersect each other.

Graduated—Marked with degrees.

Gravity—Weight. Tendency to a centre.

Heliacal—The heliacal rising of a star is just before

Hemisphere—The exact half of a sphere or globe.

Horizon—The line which terminates our view of the heavens.

Horizontal Line—A line drawn parallel to the horizon.

Inclination—The angle made by the orbit of one planet with that of another.

Incidence—The striking of one body on another.

Ingress—The sun's entrance into a sign or degree of the ecliptic.

Latitude—The latitude of a star or planet is its distance from the ecliptic, north or south towards the pole of the ecliptic. Latitude of places on the earth is reckoned north and south from the equator.

Libration—A term used to denote the irregular motion of the moon on her axis.

Longitude of the stars and planets is counted on the ecliptic, east and west from the intersection of the ecliptic and equator at Aries. Longitude of places in England is reckoned from the meridian of Greenwich, east and west upon the equator.

Mean Distance—That between the greatest and least distance of any body from the sun.

Mean Motion—That between the swiftest and slowest motion of a planet.

Meridian—A great circle of the sphere, passing over any place, and through the north

and south poles of the globe, being perpendicular to the equator.

Minute—A minute in time is the 60th part of an hour;—in motion or space, the 60th part of a degree.

Month, Lunar—The time in which the moon revolves round the centre of gravity between herself and the earth: viz. 27 days, 7 hours, and 43 minutes

———, *Synodical*—The period in which the sun, moon, and earth are in a direct line with each other. It consists of 29½ days.

———, *Solar and Calendar*—The time of the earth's moving through 30 degrees of the zodiac, which occasions an apparent motion of the sun through that space, and is completed in 30½ days.

Nadir—The point opposite to the zenith exactly under our feet.

Nodes—The two points of the ecliptic are intersected by a planet's orbit.

Oblate—Flatted at the poles.

Oblique—Slanting, not perpendicular.

Opaque—Obscure, not transparent.

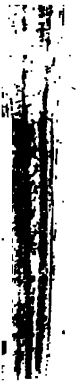
Opposition—The situation of two celestial with respect to each other, when

[redacted]

sed to be drawn parallel to the ecliptic
celestial sphere.
on—That part of a planet's orbit in
i it is nearest the sun.
ry—The circumference of any regular
:.
:al—Happening at stated times.
—The different forms exhibited by any
.ial body in its changes, as those of the
.
enon—An extraordinary appearance in
'e.
ena—Plural of phenomenon.
-A flat superficies.
ade—Going backward.
ion—The circular course of any body
i returns to the point where it first be-
.o move.
—A small planet which attends and
ves round a larger.
—The 60th part of a minute, in time,
)n, or space.
—The aspects of the planets when they
0 degrees distant from each other.
—Relating to the stars.
l Points—The most northern and
iern limits of the sun in the ecliptic.
d—An oblate or oblong body, approach-
o the form of a sphere.
s—*Those* points of the moon's orbit in
i she is at new and full.
—*A* planet's passage over the face of

Zenith—The point directly over our he
The opposite to the nadir.
Zodiac—A circle of animals.
Zone—A belt or girdle.

END OF VOL I.



AUG 2